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## Forthcoming Events.

DECEMBER 11.

*Institute of British Foundrymen (London Branch)*:—Annual dinner.

DECEMBER 14.

*Sheffield Society of Engineers and Metallurgists*:—Ordinary Meeting at Sheffield. "Elasticity in Metals and its Relation to Fatigue," Paper by D. Hanson, D.Sc.

*Ceramic Society*:—Ordinary meeting at Stoke-on-Trent. "Insulation of Ceramic Kilns" and "High Temperature Insulation."

*Institute of Metals (Scottish Local Section)*:—Ordinary meeting at Glasgow. "Aluminium and its Alloys as used for Engineering Purposes," Paper by Harry Hyman, Ph.D.

DECEMBER 15.

*Staffordshire Iron and Steel Institute*:—Ordinary meeting at Dudley. "Wrought Iron," Paper by S. J. Astbury.

**THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.**

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***Foundry Trades Equipment & Supplies Association.***
**Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.**

## Internal Transport.

Every live foundryman is fully aware of the importance and urgency of this question. Every moulding machine manufacturer is cognisant of the fact that at some time or other he has had a perfectly good installation ruined through the inability of getting sand and boxes up to the machine and away from it with adequate speed to do justice to the machine. Foundry owners tell us that they would like to install this or that machine or a battery of machines, but they say that to ensure success a new shop would have to be built round the plant envisaged. Now next June a great foundry exhibition is to be staged at the Agricultural Hall, London, and we suggest that all the exhibitors of foundry plant should prepare for exhibition on their stands as many lay-outs having reference to transport as possible. Then again, as this question equally affects every supplier of plant to be incorporated into a system of the manufacturing of castings, a joint conference should be held on the subject. There is definitely a shortage of engineers who can design and equip foundries and guarantee that transport costs will be a minimum. The foundry building is just as much a tool as is moulding machine or mechanical riddle.

Many systems of conveyors have been a hopeless failure in British foundries owing to the disastrous action of damp sands on moving parts. The quicker the movement the more rapid the wear from this cause. A suggestion obviously arises, that wear would be at a minimum if the speed of the conveyor was reduced to a crawl and the quantity of sand carried increased to a maximum. We thoroughly believe that by basing sand conveyance on this principle, wear and breakdown would be well below the economic allowance permissible.

We do hope that by next June some firm will have applied this principle to practice, and be in a position to demonstrate it to the foundry world.

A development of American origin is described elsewhere in this issue which should simplify rather than complicate the transport problem as it exists for the cleaning of large castings such as are turned out in jobbing shops. We refer to the hydraulic washing of castings. Overhead travelling cranes place and remove the actual castings into the "laundry," magnet attachments handle the grids and lifters, whilst the waste water automatically removes the sand and separates the silt. We are aware that experiments have been carried out on this subject in the Broadoaks Foundry, and we would not be surprised if other concerns have also made experiments. Whether these have been partial or complete failures or successes, it would be appreciated by the trade as a whole if those responsible for their initiation and conduct would table their results for the benefit of the foundry world. It is problematic as to whether the system is applicable to any real extent in Europe, but when foundry executives are studying the costs to be associated with it, we insist that due regard must be paid to what we feel sure would be lower transport expenses.

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## Institute of Metals.

### North-East Coast Local Section.

Dr. Maurice Cook, M.Sc., lectured on "The Solidification of Metals" to members of the local section of the Institute of Metals at a meeting held in Armstrong College, Newcastle-on-Tyne, December 1. In the absence of the Chairman (Mr. H. J. Young, F.I.C.), the meeting was presided over by Mr. H. Dunford Smith.

Dr. Cook commenced his lecture by remarking that the microscope had probably told people more than anything else had about the solidification of metals, but that it had its limits. A new method had recently been introduced, however, and had enabled the investigator to penetrate more deeply into metallic structures, namely, the X-ray. This made it possible for one to get an idea of the internal structure, or the fundamental structure of the metal, *i.e.*, the arrangement of the atoms. The application of the ultra-violet light was another method. This would take one twice as far as the microscope, but, up to the present, there was no practical method of applying ultra-violet rays.

There had been much work done on the subject of the atom, but there were still people who possessed the idea that an atom was a small *solid* body. This was quite a wrong idea, because, of course, the atom was space more than anything else.

When in the liquid state we have to imagine the atoms of a metal as being without order, but when the heat has been extracted from the crucible, and gives a temperature approaching the freezing point, the atoms begin to range themselves on a definite plan. The rate of cooling had, of course, an effect on the crystals of a pure metal or an alloy.

The process of crystallisation or solidification of pure metals and of several alloys was fully described by the lecturer, who explained the various crystalline structures by means of a large number of microphotographs which he showed on the screen. In several cases the outstanding connections between micro-structure and physical properties were indicated.

A short *résumé* was given on the history of nickel, the lecturer stating that this metal was discovered in the year 1750-1, but for nearly one hundred years it did not find very much industrial application, simply because its properties were very little known. One "property," however, *was* known, namely, its lack of malleability, and in 1881 the extraordinary discovery was made that if a very small amount of metallic magnesium was added to the nickel the resulting ingot was perfectly malleable and could be rolled when hot or cold. Without the magnesium it could not be rolled at all. Until about 12 months ago the general belief had been that this lack of malleability was due to the presence of oxygen and that the magnesium took up the oxygen; in other words, it de-oxidised the nickel. It was discovered, however, that even 0.24 per cent. of oxygen, which was vastly in excess of that encountered, had no influence whatever on the malleability of the nickel. Furthermore, none of the elements mostly found in that metal (except sulphur) affected the malleability in any way when present up to about 10 per cent. When the amount of sulphur exceeded 0.005 per cent., however, the metal definitely lost its malleability, nickel-sulphide being very brittle and weak.

In addition to magnesium, manganese was sometimes added for the purpose of increasing malleability, but it was not so effective as magnesium.

A hearty vote of thanks was accorded to the lecturer.

---

**Hardness-Testing Machine.**—An interesting and important scientific invention relating to the testing of hardness in materials of all kinds has been demonstrated at the Shipping, Engineering and Machinery Exhibition at Olympia. It is known as the Vickers Diamond hardness-testing machine, and, as a result of its use, a degree of accuracy in recording hardness is reached which hitherto it has been impossible to attain. This machine was installed on the Stand (No. 10) of Messrs. Vickers-Petters, Limited.

## Mr. W. Roxburgh joins Fordath Company.

There are few better-known foundrymen in Great Britain than Mr. W. Roxburgh, who for 18 years has controlled the extensive foundries of the British Thomson-Houston Company, Limited, of Rugby. He is now following the ever-increasing migration of foundry executives to the equipment and supply side of the industry, and on January 1,

MR. W. ROXBURGH.

1926, joins the directorate of the Fordath Engineering Company, Limited, of Hamblet Works, West Bromwich, the manufacturers of the well-known "Glyso" core compounds. We understand that this company is to widen its sphere of activities, and in this connection the extensive experience of Mr. Roxburgh should prove most valuable.

## Correspondence.

*[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]*

### Perlit Iron.

*To the Editor of* THE FOUNDRY TRADE JOURNAL.

SIR,—Your correspondent "A Foundry Director" has on several recent occasions raised a number of important points regarding Perlit iron, and expressed certain views, which in some respects coincide with my own.

I think, however, that he is under a misapprehension regarding the joint meeting of the Institution of Mechanical Engineers and the Scottish Branch of the Institute of British Foundrymen, held in Glasgow on November 19. This meeting was a continuation of those held last session for the purpose of discussing Diesel Engine Castings on the basis of the notes presented by Professor Mellanby, Mr. Richardson, Mr. Wm. Bell and myself. Messrs. Young and Gresty were in the same position as any other member of the audience; their remarks, although referring to "Perlit," can only be dealt with as contributions to the discussion.

I was called upon to reply to the discussion on the metallurgical aspect of the question, and the remarks I made were to that end, and in no way questions raised by Messrs. Young and Gresty.

I went pretty fully into the question of pearlitic iron nearly two years ago, and came to the conclusion that there was little to commend the process on the information obtainable. As I mentioned at the meeting, the idea is by no means new, being very old and well known. I saw low silicon iron cast into a hot mould, turning out grey, but in a cold mould white, so long ago as 1890.—Yours, etc.,

A. CAMPION.

# Hydraulic Washing of Castings.

When dealing with the Dusseldorf Foundry Exhibition we referred to the hydraulic cleaning of castings, and pointed out that several years ago Mr. Charles P. Markham had initiated work on these lines at his Broadoaks Foundry. The last number of the "Iron Age" to reach this country contains an illustrated article detailing an apparently successful plant utilising water jets for the cleaning of very large castings. The plant is installed in the foundries of the Allis-Chalmers Manufacturing Company, of Milwaukee. The importance of this question cannot be overstressed, and we are, therefore, quoting Mr. Robert A. Fiske's article in the "Iron Age" at some length. Like many other American developments, the hydraulic washing of castings was due to shortage of labour. This was in 1923, when Milwaukee suffered from an acute labour shortage. The first experiment was carried out by erecting a motor-driven centrifugal pump in the shop, leading the water outside to a vertical nozzle, and suspending the casting to be cleaned from the hook of a locomotive crane. The nozzle used was 1¼ in. in diameter, and the water pressure was 250 lbs., and, although the casting spun round and was usually out of control of the operator, it was evident that the process had merits, and experiments were carried further under a yard crane runway. There a 400-lb. pressure pump was installed, and castings to be cleaned were brought out on flat cars equipped with a motor-driven turntable. A ravine, near at hand, was dammed, the reservoir formed being both the source of water supply and a catch basin for drainage water. The work performed was satisfactory, except that it was transported too far out of its natural channels, and there could be little or no recovery of sand or core iron.

The expeditious washing of castings assured a saving in floor space, and it was at once evident that space in the foundry necessary for a washing room would actually be less than that occupied by castings waiting to be cleaned, and those which were being worked on by a crew of sixty men. Accordingly one end of the main bay was set aside for the washing room, and to-day two men do all the washing and twelve men follow up with chipping hammers. In addition, the process recovers practically all of the core and surface sand, and also saves £1,200 a month worth of core iron, which is not damaged by the hydraulic process.

### The Washing Plant.

The permanent washing plant is a structure 34 ft. by 45 ft. in floor plan by 20 ft. high. Three walls are constructed of reinforced concrete, and the end, facing the foundry, is enclosed by means of two hinged doors which are operated through a bell and crank motion by a 2-h.p. electric motor. One door leads the other slightly, the lagging door being fitted with canvas belting to act as a gasket and make the doors watertight. It requires 40 sec. to open the doors.

The roof is made in three sections, one telescoping over the other, and moving in a horizontal plane in the direction of the main crane bay. These roof sections are made of structural shapes and sheet metal, and each is separately operated on tracks on the side walls, by a separate 2-h.p. motor controlled by push buttons from the operators' cabin. The roof sections are provided with limit switches to prevent over travel. Each section is equipped with screen-protected electric light reflectors, and the uppermost section is fitted with three galvanised ventilators to remove steam and vapours from the room when it is closed.

The advantage of this construction is at once evident, for the roof sections can be rolled back and the end doors opened, thus giving the three overhead electric cranes free access to the entire floor space of the washing room.

The floor of this room slopes slightly and drains to one end of a 65,000-gal., reinforced concrete, L-shaped tank, which is below the foundry floor. Two false floors are provided around the turntables, the lower of which consists of steel pans which catch a large part of the sand and fine coke. The upper false floor is constructed of pans or trays, the bottoms of which are made of perforated plate, so that they will hold only large coke and core iron. After a washing, the overhead crane lifts out these trays, dumping the iron to one side on the foundry floor, where it is later re-handled by a magnet. The sand is unloaded on a tiled section of the foundry floor, drainage being led back into the underground tank.

### Castings Rest on Turntables.

The turntables already referred to are separately motor operated through two sets each of spur-reduction gears. The larger table, which is 20 ft. in diameter, is driven by a 35-h.p. Allis-Chambers motor at a speed of 1¾ r.p.m., and is under the control of the operators by means of remote control push buttons. This table is capable of sustaining loads of 200 tons. The larger castings have sufficient weight, so that they are not moved by the force of the impinging streams. The smaller table is 10 ft. in diameter, and is driven by a 10-h.p. motor at 3 r.p.m., and remotely controlled from the operators' house.

Dummy tops are used on the small turntables, some being made like steel baskets, and others consisting of a steel plate studded at the outer edge with steel stakes. In this way a number of smaller castings may be placed on a dummy top, and the whole lowered to the turntable, the stakes or sides holding the work so that the streams of water will not wash the castings from the turntable.

The operators' house is built of reinforced concrete, and is located in one corner near the swinging doors. It is three stories high, and is provided with a hydraulic elevator for the convenience of the operators. Waste water from the elevator plunger cylinder is used for make-up in the underground tank. A tier of screen-protected electric reflectors is arranged on each side of this house, and these are so directed that the work on the turntables is well illuminated. Two nozzles are mounted through the inner wall at each operating floor, and just above each nozzle is a wire-glass window protected by a heavy wire screen on the water or turntable side. A perforated water pipe, placed just above the glass and between it and the screen, enables the operator to flush the glass with fresh water, thus keeping it clean so that a clearer vision of the work can always be had. The glass in these windows must be replaced about once every four months, because of the sand-blasting effect it is subjected to by sand-laden water.

### Siltless Sand Recovered.

Hydraulic pressure for the nozzles is obtained by means of a 4-in. Allis-Chalmers, 6-stage centrifugal pump, rated at 800 g.p.m., against a head of 900 ft. It is direct connected to an Allis-Chalmers wound-rotor induction motor, rated at 300 h.p., 2,200 volts, 3-phase, 60 cycles, and 1,800 r.p.m. synchronous speed. Drainage water enters the far end of the underground tank from the tiled foundry floor, the washing plant floor, and the exhaust of the elevator plunger cylinder. It passes alternately under and over seven ⅝-in. boiler-plate baffles arranged in the end of the tank opposite from that at which the pump draws water.

It is found that heavy sand settles in the first two baffle compartments, from which it is taken by a bucket, suspended from the overhead crane, and is unloaded on the tiled portion of the foundry floor. It is allowed to drain for twenty-four hours, and is then screened, passed over a magnetic pulley, and delivered to storage bins for re-use. The fine silt which collects in the remaining baffle compartments is cleaned out every thirty days with the crane bucket. At present no use is made of this silt, although chemists believe that it will make a good paint pigment.

The hydraulic pump motor is remote controlled from push button stations in the operators' cabin. All remote control equipment was furnished by the Cutler-Hammer Manufacturing Company, Milwaukee. An automatic float switch is also provided, which either prevents the motor from being started or shuts it down in the event of low water in the tank. A further safeguard is provided in a switch, attached to the door leading from the first floor of the operators' house

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into the washing room, whereby the pump motor cannot be started unless this door is closed. If the door is opened when the motor is running, it is immediately shut down. In addition, each stop push button is so designed that, by pressing the button in and giving it a quarter turn, the motor is stopped, and cannot be restarted until that button is released. This gives the operator, working near any one of the six control stations, full power over the water supply situation in case of an accident or a misunderstanding.

The water is controlled by a starting and stopping pump. A feature of this installation is that no valves are provided between the pump and the nozzles, the only control being that of starting and stopping the pump. The reason for this is that if valves should be closed and the motor continued to operate, the work done in churning the water in the pump would cause excessive heating, which would result in damage to the unit. Al water-pipe fittings were made by Crane Company, Chicago, and are for 500-lb. hydraulic pressure.

The nozzles, which vary from $\frac{5}{8}$ in. to 1 1/16 in., are made of bronze, and are so designed with a split water-way that the thrust otherwise present is eliminated. The nozzles are ball-bearing in the horizontal plane, and are counterweighted so that very little muscular effort is required to move them or to hold them at any angle. Only two nozzles are used at a time, usually one $\frac{5}{8}$ in. and one 1 1/16 in., under which condition a pressure of 425 lb. is to be had at the nozzle throat. Immediately back of the nozzle tip are guide vanes, which prevent the water from whirling, and thus greater force is obtained when the stream strikes the sand core or casting.

### Cycle of Operations.

A complete operation consists of opening the end doors and rolling back the roof. The crane then loads the turntables, and the operators merely press buttons to again close the doors and slide the roof panels back in place. The lower door in the operating room must be closed, and then the pump can be started from remote control stations. One operator directs a stream of water on the work on each turntable, and has under his control the rotation of the turntable on which he is working.

When washing is complete, the pump motor is stopped, the doors opened, and grids or grate bars, if such were used, are removed by the crane, after which the piece is taken to the chipping floor.

A natural question is—what is the effect of streams of cold water on hot castings? The experience at this plant is that castings, such as gears and flywheels, should be allowed to cool down to about 200 deg. Fahr. before washing. Less complicated castings may be washed at a higher temperature without detrimental effect. In fact, the general run of castings can go to the hydraulic cleaning process at very nearly the temperature at which a man with a chipping hammer would be able to work on them.

This foundry is particularly clean and free from dust at the cleaning end. This is largely due to the hydraulic washing of castings. The workmen enjoy using the new method, for it is far less laborious than hand-cleaning methods. Furthermore, it is much cleaner both as to the air which the men must breathe and also as to their persons.

Amongst the illustrations is a cast-iron turbine runner after washing for 1 hr. and 40 min.. The total washing time was 14 hours, as compared with 600 hrs. under the old system. Seventy tons of material was washed off.

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AT THE LINCOLN COUNTY COURT last week, Mr. W. F. Oates, a mineral merchant, Westcar, Lime Tree Avenue, Retford, was granted his discharge from bankruptcy.

MEMBERS OF THE Sheffield Metallurgical Association heard an interesting lecture last week on "The present economic position of the iron and steel industry," by Mr. M. S. Birkett, statistical officer of the National Federation of Iron and Steel Manufacturers. Mr. G. R. Bolsover, president of the Association, occupied the chair.

## Foundry Queries.

### Casting Brass on Metal Rollers.

Trouble is being experienced when casting brass on to cast metal rollers. The rollers are 24 in. long and 6 in. dia., the brass being $\frac{5}{8}$ in. thick machines to $\frac{1}{2}$ in. The method used is to dry the moulds and cast them on end, the metal roller being machine-grooved. This is heated and dusted with powdered resin, and is cast up whilst still hot. The mould is top poured, and at the top end a ring of about $\frac{1}{2}$ in. long is added for cleaning the brass. The trouble is that blowholes appear about 6 in. from the top end of the casting, which have to be either "burned" or "pigged"—an obviously unsatisfactory method. Any information will be much appreciated.—T. D.

### Coal Dust.

As a young reader of the Journal, I shall be glad if some of your subscribers experienced in ironfounding can enlighten me on the uses of coal dust.

I understand coal dust is used extensively in ironfounding, more particularly (probably exclusively) in green-sand moulding, and as I am desirous of having particulars regarding its use, perhaps some of your many readers will oblige by enlightening me by answering the following questions:—

1. For what purpose is it used?
2. What proportions of sand and coal dust are used in, say, heavy pipe work, rain-water goods, light grate work and general engineering castings?
3. What is an ideal analysis for the various classes of work enumerated in question No. 2, and what mesh or meshes of sieves must it pass?
4. After each mould is cast, must the same quantity of coal dust be added to the sand for succeeding moulds?
5. Does the use of coal dust minimise blacking?
6. Can it be used with advantage in dry-sand moulding?

"APPRENTICE."

## Correspondence.

*[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]*

### Nickel-Chromium Resistance Alloy.

*To the Editor of* THE FOUNDRY TRADE JOURNAL.

SIR,—The paragraph in your last issue under this heading is interesting reading, but it is not quite clear if the alloy mentioned is of British or American production.

British nickel-chromium alloys, both simple and in association with a third element, have been commercial products for a long time in this and other countries, and the engineer knows to-day that this particular alloy is undoubtedly satisfactory for temperatures at which other metals collapse, and is to be relied upon for withstanding high temperatures and corrosive action.

I have used a well-known English nickel-chromium alloy which effectively withstands temperatures up to 1,150 deg. C., and is extensively used for carburising pots and tubes, hardening boxes and pots, annealing pans, pyrometer tubes, conveyor chains in furnaces, valves for superheated steam, etc., retorts, stills and muffles, loco. deflector plates, firebars, glass moulds, etc.

The tensile strength at atmospheric temperature is 30 to 35 tons per sq. in.; at 1,000 deg. C., 12 to 15 tons per sq. in. The co-efficient of expansion is 0.0000093 per deg. C. Castings from this alloy are from 30 to 50 per cent. lighter than similar castings in iron or steel, and their life is from twenty to thirty times as long. They do not oxidise, distort, or crack.—Yours etc.,

H. E. SOMMERFIELD.

Charterhouse Chambers,
Charterhouse Square, London.
December 9.

# The New Wüst Furnace for Refining Special Cast Iron.

By Dr. Th. Klingenstein (Eng.), Zuffenhausen.

The production of special grey cast iron has made considerable progress during the past few years. In conjunction with science, the manufacturer has endeavoured, with the aid of the most diverse processes and working in the most diverse directions, to bring about an improvement in the metal, either by influencing the method by which it is melted, or by subjecting the melted metal to after-treatment. Thus such questions as the Schürmann furnace, desulphurisation, Lanz Perlit, etc., have come to be fully discussed. Pure science also has taken an active part in investigating the question of refining cast iron by the systematic improvement of its structure, and in giving the manufacturer principles for its systematic production. If the results of these efforts are summarised, it may be said that the industry in general considered that the goal had been reached with the recognition of the fact, long known in many works, that the mixture for special cast iron must be such as to produce as pure a pearlite structure as possible, *i.e.*, with a moderate carbon and silicon content. This, however, is not quite accurate, and for the following reasons:—

FIG. 1.—GRAPHITE STRUCTURE IN HIGH CARBON PEARLITIC CAST IRON. ×100 DIAS.

It is beyond doubt that a pearlitic structure,

FIG. 2.—PEARLITIC STRUCTURE WITH LARGE GRAPHITE PLATES. ×500 DIAS.

owing to its eutectic nature, is able to impart to the metal qualities which make it superior to any other ferritic material. Nevertheless, normally the separation of the graphite still interrupts the structure of the grey cast iron according to its quantity and nature, and very materially prejudices the strength properties. For from the fact that the material solidifies pearlitically, it by no means follows that the graphite is present in a fine distribution favourable to strength.

Figs. 1 and 2 show the structure of a casting which, notwithstanding its pure pearlitic nature, showed a Brinell hardness of only 160; this was due to the numerous and coarse graphite separations intercalated in the structure. The amount of graphite can naturally be readily reduced by the reduction of the total carbon content; at the same time the individual graphite lamellæ are also separated in finer form, as the amount and the concentration of the carbon content have doubtless an influence on the separation of the graphite.

Every foundryman knows, however, how difficult it is in the cupola furnace to keep the carbon content low and uniform. The effect of the charge coke, and especially also of the bed coke, are so important, and, in particular, so incapable of control, that the desired result in regard to the carbon content can be attained only with great uncertainty. The diagram shown in Fig. 3 gives the result of tests made by the writer, in which—as is apparent from the following table—the bed coke or the charge coke were varied. The procedure was that first of all a mixture was melted with the normal coke charge customary with ordinary

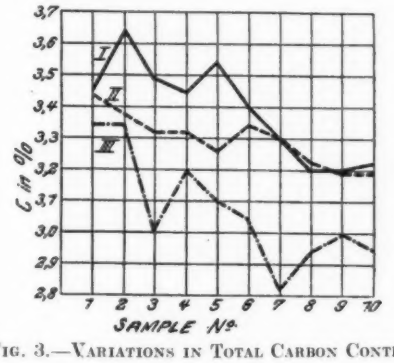



FIG. 3.—VARIATIONS IN TOTAL CARBON CONTENT.

machinery castings, and ten samples were taken, uniformly distributed over the entire heat, the carbon contents of which are comprised in curve I. Thus the carbon content diminishes with the duration of the heat, that is with the gradual consumption of the heating coke. A second heat with the same charge, but with 10 per cent. less bed coke, gave curve II inserted in the diagram. As this method of melting also did not lead to the desired result, in the third heat, in addition to the 10 per cent. reduction of the heating coke, the charge coke also was reduced from 9 to 8 per cent. in the first furnace charge, when curve III, shown in the diagram, resulted. In all three cases the carbon content of the charge was 3.06 per cent.

| | Coke. Per cent. | Charge coke. Per cent. | Total coke. Per cent. |
|---|---|---|---|
| 1st day of test .. | 3.6 | 9 | 10.2 |
| 2nd day of test .. | 3.3 | 9 | 9.5 |
| 3rd day of test .. | 3.2 | 8 or 9 | 8.0 |

From this it is apparent that the carbon content can always be kept down in this way, but at the same time it should not be forgotten that this takes place at the expense of the temperature of the melted iron, and that with the simultaneous reduction of the carbon content and the temperature of the iron, the spectre of spoiled castings is evoked. Even mixing with wrought iron gives only partial success, inasmuch as by doing so it is generally only possible at best to get down to 3.1 to 3.2 per cent. C., unless it is a question of very thick-walled castings, for which cold melting is practicable. Moreover, in small tappings of 15 to 16 cwt. from furnaces without a receiver no uniform metal can be cast owing to the irregular melting, so that, for example, one tapping may have a high and the next a low carbon and silicon content.

It is true that at present efforts are being made to introduce the electric furnace into foundry work. In view of its multifarious possibilities in use, this furnace is ideal. In most parts of Germany, however, its use is impossible owing to the high cost of current, and even where this might be practicable the high first cost of the installation might in many cases prove prohibitive.

In these circumstances oil-firing has actually been able to make progress, and has obtained a footing, particularly in the production of malleable cast iron. These furnaces, however, which are generally tilting furnaces without crucibles, have been used only for special cast iron, for on the one hand the quantity produced was much too small, while on the other their operation was extremely expensive, as an oil consumption of about 25 per cent. of the charge had to be reckoned with.

Efforts were therefore directed to the construction of an oil-fired furnace which can be worked continuously like a cupola furnace—that is, which possesses its advantages without its disadvantages as regards the uncertainty of the charge. Such a furnace is the reverberatory-cupola furnace fired with oil and built according to the Wüst patent, and it fulfils all the above requirements.

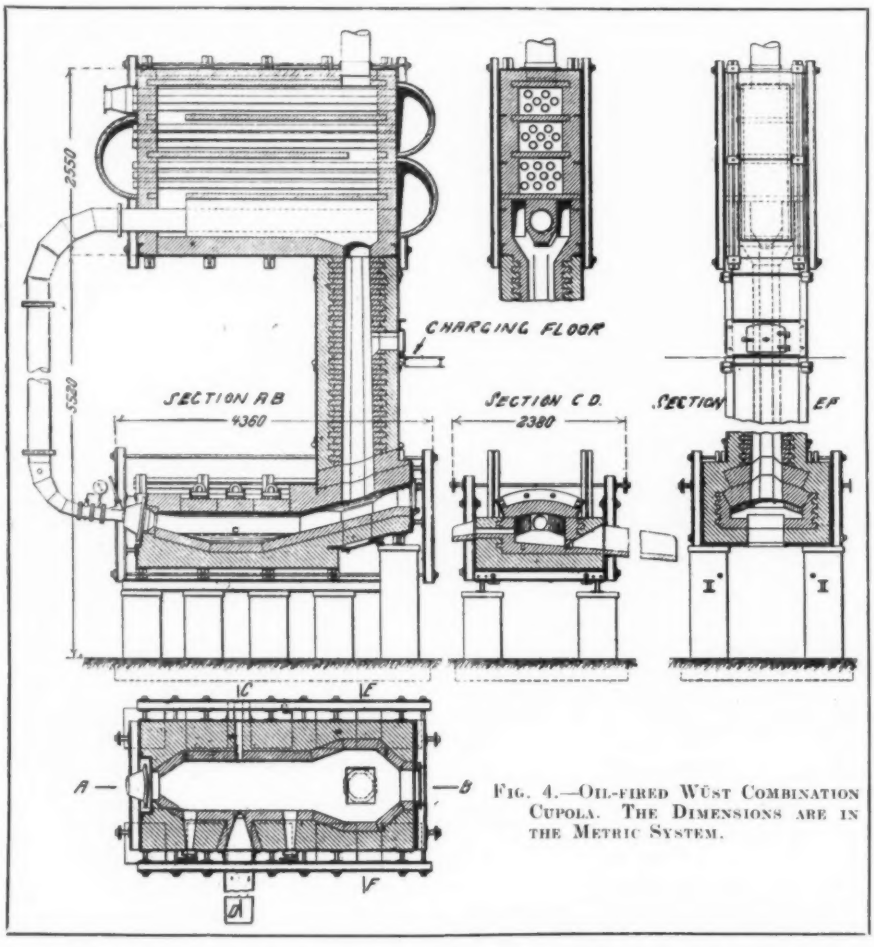



FIG. 4.—OIL-FIRED WÜST COMBINATION CUPOLA. THE DIMENSIONS ARE IN THE METRIC SYSTEM.

The construction of the furnace is shown in Fig. 4. It is in principle a reverberatory furnace, in which the oil burner enters on one side while a charging shaft is erected on the other. The flame developed by the oil burner first sweeps the bath, strikes against the lower part of the charge column in the charging shaft and melts it down for running off into the hearth, while fresh material is charged down from above or delivered through the throat opening. The escaping gases sweep through a pre-heater and heat the blast air on the counter current system, blast temperatures of 400 deg. C.—at times even 600 deg. C.—being obtained. The slag is drawn off on the side opposite the tap-hole. On the floor of the charging

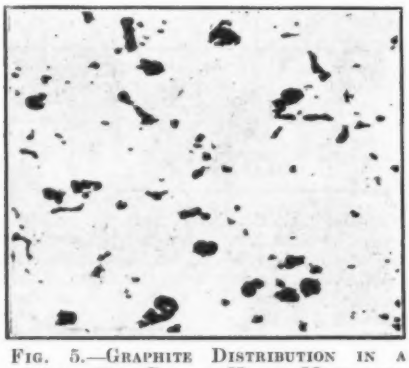


FIG. 5.—GRAPHITE DISTRIBUTION IN A 30-MM TEST-BAR OF HEAVY MACHINERY IRON MADE IN THE WÜST FURNACE. × 1,000 DIAS.

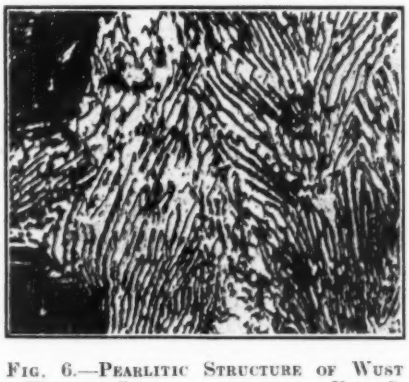


FIG. 6.—PEARLITIC STRUCTURE OF WUST FURNACE IRON, AS SHOWN IN FIG. 5. × 1,000 DIAS.

# Cupola- and Wüst Furnace-melted Irons from Identical Mixings.

×800

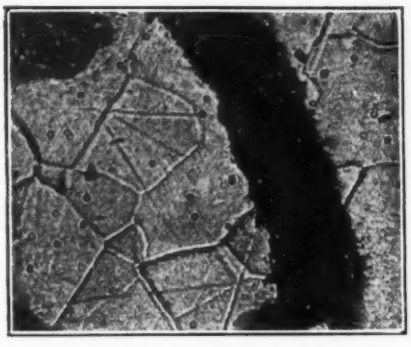


Fig. 7.

×800

Fig. 11.

Very Soft Iron.

×800

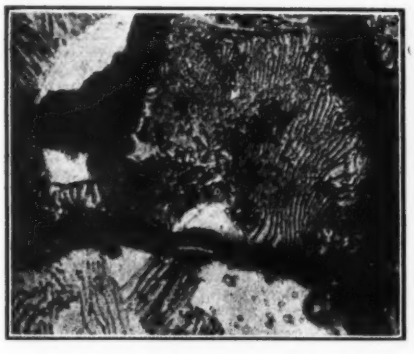


Fig. 8.

×800

Fig. 12

Soft Machinery Iron.

×800

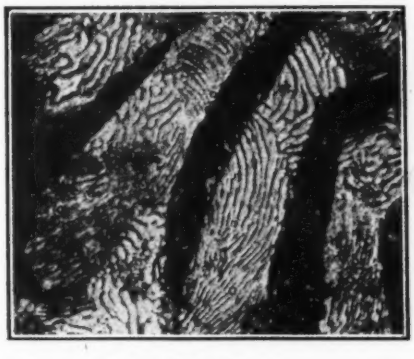


Fig. 9.

×800

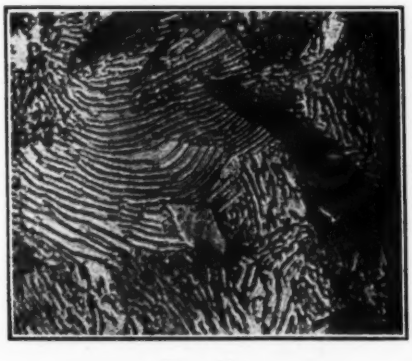


Fig. 13.

Hard Machinery Iron.

×800

Fig. 10.

×800

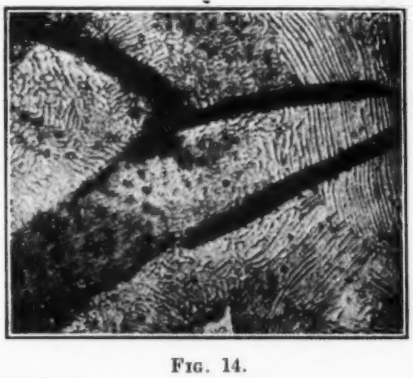


Fig. 14.

Very Hard Machinery Iron.

shaft there is a flap, by which the shaft is made easily accessible. The arch of the floor consists of removable covers, so that the necessary repairs can be quickly and conveniently carried out.

| | | | |
|---|---|---|---|
| Total charge | 4,500 kg. (9,900 lbs.) | 4,200 kg. (9,240 lbs.) | 4,000 kg. (8,800 lbs.) |
| Output per hr. | 1,125 kg. (2,475 lbs.) | 1,050 kg. (2,310 lbs.) | 1,020 kg. (2,244 lbs.) |
| Oil consumption in pre-heating .. | 1.1% | 1.6% | 0.87% |
| Oil consumption in melting .. | 6.9% | 8.7% | 8.9% |
| Total oil consumption .. | 8.0% | 10.3% | 9.8% |

Coal tar oil with a calorific value of about 9,200 cal. is used as oil fuel. As in the cupola furnace, the charge is delivered from the charging stage with a lime addition of 1 to 2 per cent., the sole difference being that *no coke* is necessary. In Table I several examples are given of heats in a 1-ton furnace, which has been in successful operation in the foundries of the Esslingen Maschinen-Fabrik for more than a year, this being the first used there. The table gives all figures of importance. The figures in the table below also give particulars regarding the efficiency of the furnace. These are derived from the heat of a special charge with a melting point of about 1,260 deg. These figures show, like the previous table, the low oil-consumption and the hourly output of the furnace, which can, of course, also be built for larger outputs.

The temperature of the tapped iron is between 1,500 deg. and 1,600 deg. The improvement in quality of grey cast iron melted by this method consists, apart from the low sulphur content, in the finer graphite separation and in the possibility of obtaining with accuracy a uniformly low carbon content of the particular analysis desired.

Fig. 5 shows the graphite distribution in a 30 mm. test-bar of the heavy machinery casting mentioned above.

The graphite is separated more in the form of temper carbon, and not in the usual lamellar form. It is obvious that this form of graphite, which is extraordinarily conducive to strength, is attributable to the high melting temperature. The otherwise pearlitic structure is shown in Fig. 6.

From what has been said it follows that in order to refine cast iron further the formation of the graphite must be influenced in the first place. As the melting temperature plainly exercises a material effect in this respect, the Wüst furnace, in contrast with the cupola furnace in which the height of the melting temperatures is restricted, should prove exceptionally qualified to promote the realisation of this endeavour.

The illustrations of micros. of four special charges of the Esslingen Maschinen-Fabrik serve to show the difference between types of iron melted in the cupola furnace and those melted in the Wüst furnace.

The first series (Figs. 7 to 10) illustrates the structure of the four mixtures on being melted in the cupola furnace, while the second series (Figs. 11 to 14) shows that of the charges, identical even to the carbon content, which were melted in the oil-fired reverberatory cupola furnace. The difference between the structure in the two cases is very striking, and although the structure formations apparent in the first series do not absolutely indicate a low-grade material, the difference is nevertheless very great and the illustrations of the iron melted in the Wüst furnace point to specially outstanding properties in the latter.

TABLE I.—*Examples of melting in the 1-ton Wüst Furnace.*

| Nature of metal. | Medium machinery castings (reducing heat). | | | Medium machinery castings. (reducing heat). | | | Heavy machinery castings (oxidising heat). | | | Heavy machinery castings (oxidising heat). | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Charge .. .. | 49.3% Concordia iron<br>49.3% III. German<br>1.4% E.K. packets | | | 20% Hematite<br>10% III. German<br>10% Scrap<br>59% Runners, etc.<br>1% E K-packets | | | 12% Low carbon Concordia iron<br>12% Siegen iron<br>26% Scrap<br>40% Runners, etc. | | | 12% Concordia iron<br>6% } Siegen<br>6% } iron<br>10% Machinery scrap<br>66% Runners | | |
| Analysis. | Of the charge. | Of the metal. | Increase and decrease | Of the charge. | Of the metal. | Increase and decrease | Of the charge. | Of the metal. | Increase and decrease | Of the charge. | Of the metal. | Increase and decrease |
| Si .. .. | 2.10 | 2.04 | −2.85 | 2.51 | 2.40 | −4 | 1.68 | 1.66 | ±0 | 1.76 | 1.67 | −5.1 |
| Mn .. .. | 0.83 | 0.83 | ±0 | 0.76 | 0.76 | ±0 | 0.96 | 0.90 | — | 1.04 | 0.96 | −7.0 |
| P .. .. | 0.36 | 0.36 | ±0 | 0.46 | 0.46 | ±0 | 0.35 | 0.42 | −5 | 0.39 | 0.39 | ±0 |
| S .. .. | 0.021 | 0.021 | ±0 | 0.073 | 0.055 | −28 | 0.079 | 0.077 | ±0 | 0.074 | 0.074 | ±0 |
| Total C .. .. | 2.97 | 3.06 | +3.03 | 3.47 | 3.31 | −5 | 3.20 | 2.70 | −15 | 3.20 | 2.70 | −15.6 |
| Tensile strength .. | 16 tons sq. in. | | | 14 tons sq. in. | | | 21 tons sq. in. | | | 19 tons sq. in. | | |
| Transverse strength | 28 ,, | | | 24 ,, | | | 35 ,, | | | 35 ,, | | |
| Brinell hardness .. | 225 | | | 195 | | | 215 | | | 235 | | |
| Total charge .. | 8,919 | | | 7,700 | | | 10,560 | | | 7,700 | | |
| Output per hour .. | 1,982 | | | 2,369 | | | 2,310 | | | 2,369 | | |
| Oil consumption in pre-heating .. | 1.0% | | | 1.9% | | | 0.9% | | | 1.9% | | |
| Oil consumption in melting .. .. | 10.2% | | | 8.9% | | | 9.8% | | | 8.9% | | |
| Total oil consumption .. .. | 11.2% | | | 10.8 % | | | 10.7% | | | 10.8% | | |

## Book Reviews.

**Mechanical World Year Book, 1926.**—Published by Messrs. Emmott & Company, Limited, 65, King Street, Manchester. Price 1s. 6d., net. Most of our readers are familiar with this useful little book. The new features of interest to foundrymen in the 1926 edition are some new notes on grinding and the lifting capacity of chains and ropes.

**Studies on Repetitive Work, with Special Reference to Rest Pauses.** By S. Wyatt, M.Sc., and J. A. Fraser, M.A. Being Report No. 32 of the Industrial Fatigue Research Board. Published by H.M. Stationery Office, Kingsway, London, W.C.2.

Rest pauses are becoming more and more important for repetition foundries, and though this report deals with laundry work and stamping cigarette-tin lids, the basic principles are the same. Published figures go to show that, despite a reduction in working time, an increase in output of 5 to 10 per cent. is assured. To obtain the best results the pauses should be expected, as output increases just before the rest. A new factor has been discovered, that the workers are influenced as to speed by their neighbouring operatives. It has, however, long been axiomatic that the speed of the overhead crane influences the general speed of working in a factory.

We tend towards the view that each individual factory should carry out its own experiments, as conditions are so variable that no published work can be of direct interest to any particular factory. The underlying principles are, or ought to be, well known, and all that future work can do is to amplify the data already available.

MR. WILLIAM CLARK, a director of Vickers, Limited, Sheffield, has intimated his intention of retiring at the end of the year.

# The Training of Foundrymen.

## Mons. E. Ronceray's Address at Birmingham.

In introducing the lecturer for the evening, MR. C. RETALLACK, who presided, said that for many years he had been impressed with the need for something to be done for the education of the young moulder. It was not a craft that appealed to most boys. Already something had been done at Sheffield, and very good work had also been done at the Technical School at Wednesbury. He had paid a number of visits to Paris to see the provision that was made there for the technical training of the foundryman, and each time he was more impressed with the genius of Mons. Ronceray and the success which was attending his labours. The present meeting was the outcome of the impetus which he derived from an inspection of what was being done. It was often said that the foundry industry was not making progress at the same rate as the engineering industry. It was suggested that in their craft they still belonged to the Queen Anne period and that they had a venerable attachment to the methods practised by their grandfathers; that in the foundry all was rule of thumb, and that it was the last place to introduce modern economic practice and conditions. Whatever they might have to say about the lethargy of the last fifty years—and he admitted that we had been lethargic in this country—there had now come a vital awakening in their craft. There was now a spirit of inquiry and a determination to explore every avenue which would result in eradicating what was erroneous and applying the methods of research to design, patterns, gating, moulding, refractories, temperatures, and especially to the material used. The British Cast Iron Research Association had become a great and living force. Ably led by its director, Mr. Pearce, and by Mr. Fletcher, research to that body was not merely a question of papers and essays. Every defective casting submitted was microscopically analysed and reported upon, and the whole *modus operandi* of foundry practice and material was under review for the benefit of the members. Mr. Retallack expressed his appreciation of the work of THE FOUNDRY TRADE JOURNAL. No trade paper had made more rapid progress, he said, and the information published was of the greatest value both to the students and the workers in the foundry craft. He referred to the difficulty of obtaining skilled moulders, many of whom, he said, went to the U.S.A., where they got increased remuneration. Boys as a rule did not like foundry work, which was laborious and dirty. It was a trade, however, that required skill, and never were the requirements so exacting as they were to-day. What they needed to do was to link up the technical schools with practical work in the foundry, to connect the boy at the technical school who promised well in his metallurgical studies with practice in a model or other foundry. For this development they had to go to Mons. Ronceray, the living embodiment of ironfoundry in all its multitudinous branches and details. The outstanding feature of Mons. Ronceray as a founder was that he was bringing into daily practice in the foundry his extensive knowledge of metallurgical technique and kindred investigations. Whether it was the pencil downgate or the syphon triplicate pouring brick, he had a faculty possessed by few scientists, who were too much confined to the laboratories, and never got down to the foundry floor.

The training of the juniors merited careful attention, and they ought to give the greatest attention to boys who had a passion for foundry work, and there were some. He mentioned that the French Government had recognised the splendid work which Mons. Ronceray was doing by making him a Chevalier of the Legion of Honour.

MONS. RONCERAY, who was very warmly received, said it was always with renewed pleasure that he came to lecture in Birmingham, where everything relating to the foundry trade was so much appreciated. Some time ago he received a visit from his friend Mr. Retallack, who came to consult with him on the subject of foundry education. "Whether he came to me," Mons. Ronceray added, "with reference to elementary training of apprentices or for higher educational purposes I really do not know, because I have been accused of spreading my efforts over the whole field of foundry education."

### Foundry Training from Apprenticeship to the Foundry Technical High School.

The war had shattered all French organisations, most of the skilled men had been killed or were disabled, whilst requirements were enormous, and, as a leading politician said, France had to become a nation of "cadres" (staffmen) if they intended to keep their position amongst the nations. They had in consequence to frame a complete organisation of their industries. It was with the object of promoting a general plan for the foundry industry that the Author presented a paper at the first post-war conference of the A.T.F. of Paris, held in Liège in 1921.

This paper dealt more with the ascertaining of the disorganisation of the foundry training and the submission of a plan than the showing of results. The hopes and purposes of the Committees appointed to improve the conditions were expounded, and the desire that a Foundry High School should be opened to raise the scientific and technical level of foundry engineers and managers was put forward. How these ends were attained will be shown.

The three stages of foundry education are:—(*a*) The training of artisans; (*b*) the education of charge hands and foremen, and (*c*) training of foundry specialists and managers.

#### The Training of Artisans.

The greatest obstacle to foundry apprenticeship is the reluctance of boys to enter the trade. Whilst engineering or electrical trades find as many apprentices as they like, it is a practical impossibility to convince boys to become moulders. They notice that engineers or electricians are invariably well-dressed, superior men, whose function it is to move handles or levers, to drive

FIG. 1.—MOULDING SHOP WITH APPRENTICES AT WORK.

automobiles, ships, aeroplanes, or something of this description. Their choice is governed by the romantic appearance of the profession, and it is a disappointment for them to discover later on that, very often, their work is dirty and obscure, unemployment frequent and wages modest. The foundry world realises that moulding is not the dirty, stupid job that some people think it is. The foundry is the basis of all engineering trades. It presents a vast number of interesting jobs; possible improvements are enormous, and the prospects are very promising for good men. The foundries become every day more comfortable, cleaner and better equipped, and the best men

can get very high pay in this form of employment. It is thought that in Britain also efforts are being made to attract intelligent young men; whilst it is certain that at the present time much difficulty exists in France.

It is hoped that "professional orientation," which is to be attempted in France in the years to come during the last term of elementary schools, will bring some improvement, though it has still to be proved.

Another great obstacle to apprenticeship is the lack of enthusiasm of foundry owners. It is said that apprentices are troublesome, that they cost a good deal of money, and that they leave before the end of their time. From personal experience it can be stated that there is nothing in such fears. When apprenticeship is properly organised it is a source of satisfaction. It must not be feared that the apprentices will leave the firm when their time is served; on the contrary, this is to be desired. Lack of moulders is not due to exchange of trained men, but the lack of a general training policy. In Britain it is thought that there are difficulties arising from moulders' unions. There are no difficulties of that kind in France.

### Apprenticeship Pamphlet.

To help apprenticeship, the Syndicat des Foudeurs de France has thought useful to publish a pamphlet giving general information and advice. This pamphlet contains information to help recruiting of apprentices, a contract form, legal tests relating to apprenticeship and a programme of foundry courses, which is to be developed in a text book to help the teachers and having sufficient pedagogical qualities to teach and interest his pupils. No labourer's work must be imposed to boys, otherwise they lose interest in their trade. It is wonderful to visualise the results of such methods. The boys make considerable progress, and they work with zest and enthusiasm.

### Apportioning of Period.

The total time served is three years. It is recommended to use the first year to teach the general bases of the trade, exacting from the boys good and well-finished work, rather than speed, but not to hesitate to undertake more and more difficult work as soon as knowledge and experience are acquired, at the risk of making a few wasters, which, after all, are not fruitless. The enthusiasm of boys is raised in direct proportion to the confidence which is shown to them. They get quickly discouraged if they are treated like labourers or low grade workmen, which are supposed to be only good for low and tedious work.

After one year speed can be developed by offering boys premium or piece work, but quality must be insisted upon. The difficulty of the work is increased as time goes, but after about 18 months the average boy is capable of making most of the ordinary work given to moulders, though at a slower speed. He must be given indifferently all work usually made in the shop: sweeping, gears, cylinders, engine bases, etc. If necessary the instructor should help him and try to raise his interest by comparing his work with similar work accomplished by skilled workmen.

FIG. 2.—CORE SHOP FOR APPRENTICES.

FIG. 3.—VIEW OF A MOULDING SHOP DEVOTED EXCLUSIVELY TO APPRENTICE TRAINING.

boys. This can be consulted on application to the B.C.I.R.A.

### Apprenticeship in the Foundry or at a School.

The general opinion in France is that the bulk of moulders must be trained in shops, where the work is more normal and the atmosphere more businesslike than in schools where work cannot be conducted on a sufficient scale. But proper training in the foundry requires the strict use of adequate methods; otherwise, training in school may be preferable.

The Syndicat pamphlet recommends to group the boys under the supervision of a capable instructor, and to avoid at all costs putting them under the journeymen in the foundry, who are liable to use them as labourers.

It is recommended to give them at once simple, but useful work by increasing steadily the difficulties. Every morning the castings are examined by the instructor. The wasters are carefully broken in presence of the boys. These previous examinations generally disclose the causes of the defects and their remedies. Those remedies are immediately applied and their results inspected at the next melt. If especially interesting cases are met, apprentices are gathered to inspect them, and are questioned on the causes of wasters and remedies.

### Choice of Instructor.

The choice of instructor has a great bearing on the results. He must be a very competent man, capable of working himself, fond of boys, Drawings of castings in progress must always be in the boy's hands.

From his entrance into the shop the boy must have his own tools and a cupboard in which to keep them. He must be trained to take care of his tools, and not wander in the shop to look for a shovel, a rammer or bellows.

### Foundry Instruction Courses.

The general custom is to have foundry instruction courses twice a week, that is, 4 hours per week. Some foundries have them made during shop time, others after. The first year is generally employed to teach elementary drawing and mathematics, while the second and third years are devoted entirely to trade matters, as referred to in programmes A and B of the pamphlet. The instructor should seize every opportunity, and, if necessary, provoke it, to refer to the drawing of the casting in progress. This is an excellent method of raising the boy's interest.

Sometimes the instructor is the teacher of the foundry courses, sometimes it is another man. In this latter case the two men must work in close co-operation to avoid differences of opinion. The lessons of the teacher on sands, melting, lifting pressures, etc., must be confirmed by actual tests or observations.

### Influence of Staff.

The influence of staff on the final results may be considerable. The first conditions of success

are a complete faith in the utility of apprenticeship and the possibility of success. If the chief is convinced, he will be in a position to obtain the hearty co-operation of his assistants, the influence of which is of considerable weight in the course of time.

But his personal action may be very great. He must himself see the boys and their parents, tell them the advantages and interest of the trade and the future of it for educated people. He must induce the educated boys to enter the foundry, even if necessary by increasing their pay. Those boys generally learn quicker than the less educated ones, and are the recruits for the future staff.

Later on, the principal must exert a continuous action, keep his staff on the watch, see the boys often, adroitly praise or blame them, organise competitions, give prizes, in short, make clear the interest he bears to his boys.

### Actual State of Apprenticeship in France.

The regions which have best succeeded in the training of foundry apprentices are: Nord, Ardennes, Haute-Marne, Creusot district, and Paris region. In the last region 150 apprentices for iron, steel and aluminium and 60 for brass have passed examinations last year. The Prefecture de la Seine has awarded 15 certificates of "*aptitude professionnelle*" after examination passed by a jury named by the Prefet de la Seine. The report of jury mentioned "The whole of the members consider that, from the professional point of view, the average level of candidates was excellent. Their skill was considered either as finish of work or speed, corresponding to that of good workmen of full age." Figs. 1, 2, and 3 show a few boys at work in foundries, and Figs. 4, 5, 6, and 7 some of their work.

FIG. 4.—AN 18-YEAR-OLD APPRENTICE WHO HAS MADE THE CASTING SHOWN IN 29 HOURS AFTER 32 MONTHS' TRAINING.

FIG. 5.—A 16½-YEAR-OLD APPRENTICE WITH A CASTING HE HAS MADE IN 24 HOURS AFTER 39 MONTHS' TRAINING.

### Apprentice Schools.

Apprentice training at schools has only recently been started in France at the Institut Colbert at Tourcoing, Institut Turgot at Roubaix, Ecole de Métiers at Lyons, and is in process of organisation in various "*écoles pratiques*" and in the "*Ecoles Nationales professionnelles*" of Armentières, Nantes, Voiron and Tarbes.

The apprentices trained in these schools, so long as they do not leave the trade, which may be feared, are probably better fit to enter the lower staff of foundries than to make pure workmen. Their general education will enable them to join the staff, but their manual training will be inferior to the one of apprentices trained under proper shop conditions. The latter conditions may, however, be imperfect, in which case the school apprentices show superiority on the shop-trained ones. Whether the boys trained at school intend to become workmen or rise to foremanship, it is strongly recommended that they should improve their knowledge by spending a few years of their youth in various foundries doing actual work before finally settling down. Those desirous of advancement must not seek clerical work, but they must be anxious to complete their knowledge by assimilating industrial methods, costing, organisation, and observation of human factors.

### The Training of Foremen.

It is to be regretted that no systematic formation of foundry foreman has been undertaken either by the Government or private organisations. There is only a Sunday course in Paris, providing 20 lectures, which can hardly pass for such. The author is very sorry about this, and one of his ambitions has been to fill that gap. Circumstances have not permitted it up to now, but he hopes to be able to contribute to it in the near future on similar lines to those followed for the higher form of teaching.

In the author's opinion, the foremen's training is a very important thing comparatively easy to organise. The recruiting should be made amongst the ambitious and intelligent young men who have entered the trade either from the sand heap or through a professional school. Even the foremen in existence at present, who suffer from the lack of technical knowledge, would be eager to follow such courses. It seems, therefore, that no difficulty would be met to have students anxious to learn. The only difficulty seems to find teachers and to pay them. The foundry high school, to be dealt with later, will in a short time have widely distributed sufficient men able to teach foundry topics in a capable way. The foundrymen, their regional organisations, and the Technical Education Board, which has now special resources for this purpose, will not fail in their duty. So that everything points to a recrudescence of regional courses specially organised for foundry foreman training.

### The Training of Foundry Executives.

Up to now, the training of foundry executives has been carried in a certain number of technical colleges. Except for the Ecoles d'Arts and Métiers, this training was not in direct relation to foundry needs, but referred more particularly to metallurgy. The Ecoles des Mines, Ecole Centrale des Arts and Manufactures, Instituts Industriels devote a few lectures to foundry topics. However, the Ecole Centrale has an important

shop laboratory and well-considered courses, but short.

The Ecoles Nationales d'Arts and Metiers have for a long time been the source of foundry managers outside of theoretical courses. Practical foundry profession was taught there during three consecutive years for seven hours a day, which have been first reduced to two years at five hours per day, and finally to one year. The actual tendency is to train there non-specialised engineers, all students passing in the various shops during their first and third year of scholarship. During the second year only a certain number of students follow foundry or pattern-making courses, and very likely they will form a good part of future foundry managers when they have gained sufficient experience and knowledge. They are expected to form an important part of the students of high school.

### Ecole Superieure de Fonderie.

In his Paper presented on behalf of the I.B.F. to the conference recently held in Liège, Mr. J. G. Pearce mentions that "on foundry subjects, the scientific man can hardly start researches of value for lack of practical knowledge, while the practical man is not in possession of sufficient scientific knowledge to draw the full conclusions of his observations."

FIG. 6.—A 15-YEAR-OLD APPRENTICE WITH A CASTING HE HAS MADE IN 21 HOURS AFTER 19 MONTHS TRAINING.

It is to fill this gap and to unite in one man scientific and technical knowledge and experience that the Paris Foundry High School has been created. It is the first of its kind in the world, to the author's knowledge.

It has been created on the proposal of the author by the Syndicat Général des Fondeurs de France with the help and collaboration of the Technical Education Board.

Mr. Ch. Dufour, Chairman of the Syndicat des Fondeurs de France, put it to the general meeting on July 30, 1923, the funds were immediately raised, and the first board of directors of the new school took place at the Board of Education early in October under the chairmanship of the Minister, Mr. Gaston Vidal, assisted by Mr. Dufour and Mr. Labbé, Directeur de l'Enseignement Technique. The decree organising the school appeared on October 23, and the courses were opened in January.

It must be understood that the school is not intended exclusively to form foundry specialists, but to complete the knowledge of foundrymen, having already a general scientific training, by teaching them the special topics of the profession which are at present disseminated in technical books or Press or even not published.

The students may be either graduates from special schools or men who have risen from the bottom. As far as possible, half of the vacancies are reserved for each category. An entrance examination is to be passed by both categories, and all of them have to justify good foundry practice.

### Standard of Courses.

The standard of courses is scientifically as high as possible, consistent with the scientific training of students. It is thoroughly practical at the same time, for the object is above all to produce foundry executives or managers with a scientific training.

The method followed to reach such result is to select for each course the best specialist known. A library, with a bibliographic organisation, is being placed at the disposal of professors and students. The following *résumé* will give an idea of the topics studied with the names of teachers. The latest works published in the world have to be investigated and eventually taught.

## FOUNDRY HIGH SCHOOL.

### Course of Lectures.

*Metallurgy.*—General metallurgy (Cournot), 3 lectures. Metallurgy of non-ferrous metals, study of principal alloys (Cournot), 4 lectures. Classification of pig-irons, steels, malleable; Study of

FIG. 7.—A 15½-YEAR-OLD APPRENTICE WITH A CASTING HE HAS MADE IN 10 HOURS AFTER 15 MONTHS TRAINING.

blast furnaces; Theory of air-furnace converter, open-hearth furnace (Brull), 15 lectures, 3 laboratories.

*Physical and Chemical Study of Materials used in Foundry.*—Metallography; Study of constitution and structure, properties and treatment of metals and alloys used in foundry (Portevin), 20 lectures, 9 practical. Dilatometric study of alloys (Chevenard), 2 lectures. Investigation through X-rays of defective castings; Application of Debye method to study of alloys (Delauney), 2 lectures.

*Industrial Heating.*—Study of combustibles, combustion and furnaces (Roszak), 11 lectures.

*Geology, Mineralogy and Refractories.*—Study of principal minerals and natural substances used in foundry and industry (Bertrand), 11 lectures. Refractories used in foundry (Bodin), 4 lectures.

*Electricity.*—General notions and principal laws of electricity: Application to the foundry needs (Nugues), 12 lectures.

*Analytical Chemistry.* — Sampling; Chemical analysis and tests; Laboratory organisation (Fournel), 14 lectures, 30 practical. Industrial methods of rapid analysis (Levi), 2 lectures.

*Introduction to Foundry Work.*—General theory of moulding and pouring; Determination of acting forces in moulds (Pillon), 6 lectures. Gene-

ralities; Industrial status of foundry; General internal and technical organisation (Ronceray), 2 lectures. Materials used in foundry (Ronceray), 6 lectures. Pattern making (Masviel), 10 lectures. Scientific and experimental study of sands (Lemoine), 5 lectures; Study of foundry defects and general rules resulting (Ronceray), 2 lectures.

*General Moulding Study.* — Sand and loam moulding. Study of different processes (Debar), 2 lectures. Moulding boxes; Moulding tools (Debar), 3 lectures. Preparation of sands; Apparatus used (Lemoine), 2 lectures. Evacuation of gas in sand; Ramming (Ronceray), 3 lectures. Core making (Ronceray), 3 lectures. Pattern drawing, finishing (Debar), 1 lecture. Drying; General theory of stoves (Debar), 3 lectures. Handling of molten metal (Debar), 1 lecture. Pouring (Debar), 1 lecture. Sorting, fettling, repairing, inspection of castings (Ronceray), 1 lecture.

*Melting and Treatment of Metals.*—Blowing apparatus and their control (Bouzy), 3 lectures.

*Ferrous Alloys.*—Treatment of cast iron in the foundry; Properties of cast iron; Special irons (Lemoine), 4 lectures. Cast-iron melting, in cupola (Ronceray), 5 lectures. Cast-iron melting, in air furnace (Ramas), 1 lecture. Semi-steel (Levi), 2 lectures. High-strength cast irons (Le Thomas), 1 lecture. Malleable iron (theoretical study (Lemoine), 2 lectures. Malleable iron (practical study) (Levasseur), 4 lectures. Steel (theoretical and metallurgical study) (Vanzetti), 3 lectures. Practical study of the steel foundry with converter. Siemens-Martin furnaces and electric furnace (Vanzetti), 5 lectures. Theoretical study of electric furnace (Remy), 4 lectures.

*Non-ferrous Alloys.*—Study of copper alloys and other non-ferrous alloys (Lemoine), 5 lectures. Melting and refining; High-strength brasses (Le Thomas), 1 lecture. Light alloys: theoretical study (Lemoine), 3 lectures. Light alloys: practical study (de Fleury), 4 lectures.

*Different Kinds of Moulding; Specialities.*—Pattern plates and machine moulding (Billon and Debar), 6 lectures, 3 practical. Sweeping gear moulding and turbines (Masson), 2 lectures, 2 laboratories. Loam moulding (Fabre), 2 lectures. Special moulding of light work: stove plates, sanitary castings, radiators (Ronceray), 1 lecture. Chilled castings; Rolling mill rolls; Chilled wheels, etc. (Ramas), 1 lecture. Railway castings (Dewee), 1 lecture. Welding of cast iron (Dewee), 1 lecture. Automobile castings (Thivot), 1 lecture). Cireperdue, medals, art work, imitation bronze (Derdinger), 2 lectures. Large brass castings, propellers, high-strength brasses, bells (Gauger), 4 lectures. Pipe making, permanent moulds, centrifugal castings; Electrolytic and non-electrolytic coverings; Inoxydation, enameling (Levasseur), 4 lectures.

*General Organisation of Foundries.*—The *rôle* of foundry manager (Dufour), 1 lecture. Lifting apparatus in the foundry (Pillon), 3 lectures. General organisation; Equipment; Handling; Description of a few types of foundries (Ronceray), 2 lectures. Scientific management of foundries (Nusbaumer), 3 lectures. Cost prices; Their organisation (Feron), 2 lectures. Influence of fire losses on cost prices (Brizon), 1 lecture. Selling; Its organisation (Feron), 1 lecture.

*Graphic Work and Applications.*—Moulding studies and discussions (Ronceray and Debar), 24 lectures. Reports on visits of foundries and discussions (Ronceray, Debar, Lemoine), 24 lectures. General design of foundries; Shop planning; Study of defects (Ronceray, Debar, Lemoine).

### Graphic Work.

It must be remembered that all students have a knowledge of foundry practice, so it is no use to have practical moulding taught. It must be known before coming to the school. The students must also have a thorough practice of engineering drawing, so as to be able to express their conceptions and views.

Every 10 days they have to make the complete study of the moulding of a casting, starting with a very simple work, and finishing at the end of their work with automobile or locomotive cylinders or similar work.

The studies comprise: Approximate weight of castings; weight of metal; machining allowances; contraction allowances; methods of moulding, reasons of the choice; constructions of patterns; construction of core boxes; design of moulding boxes; detail of moulding; special precautions to take to ensure a sound casting; quality of sand used; core making, composition of sand used; mould closing; method of pouring, precautions to take; composition of metal recommended, its manufacture; heat treatment if required; estimation of time for pattern, core boxes, mould, cores; cleaning and fettling; and criticism of the design to improve the casting or speed up the work.

The object is to provide men capable of conducting the work from the beginning to the end, and to promote the organisation of studying foundry work before starting the work. There is bound to be in the future a "ways and means department" in the foundry as in the machine shop.

Every week the students, accompanied by one or two of their lecturers, pay a visit to one of the numerous foundries around Paris. Those visits are made in a quite different way from ordinary school visits. The students would have little to learn from a superficial visit, as most of them have seen numerous foundries. They are given a certain part to study, such as the melting plant, ovens, general arrangements of the foundry, lifting apparatus, core making, sand-preparing plant, etc. Some of them in rotation have to present a report with their criticisms and proposals of improvements. These reports are discussed with the teachers and these discussions are most instructive. In a very short time the students learn "how to see," to express an opinion for themselves, and eventually to become able to avoid making the faults that they have encountered.

They also have to design parts of foundries, such as the core room, melting plant, sand-mixing plant, raw material, handling, etc., so that step by step they become able at the end of the year to design a complete foundry.

During the Easter holidays a week's trip is undertaken in an industrial district, not only to visit foundries of special character which could hardly be found around Paris, but also blast furnaces, coke ovens, rolling mills, steel works, etc., so as to give the students a general view of metallurgical industries.

In addition to the periodical examinations during the year, the final classification is made by two special examinations—one at the end of the year and a second a few months' later.

The first one refers to the study of the moulding of an important casting on the same lines as during the year. Last year it was a Diesel engine cylinder. The time allowed to make the whole work was 10 hours, and remarkable solutions were presented.

The second is a paper to be presented on a subject selected by the student himself. It is a kind of simple research, affording an excellent means of appreciating the personal value of each man and the profit he has drawn from the teaching. In future these papers will be presented at the end of the year, *i.e.*, about four or five months after the end of the courses. It will have to be made in private shops where the students have been absorbed.

Last year very interesting papers were submitted, and amongst others there were: "On a chilling test for high-silicon cast irons"; "Chaplet-welding in iron castings"; "Silicon-aluminium alloys"; and "The 'life' of metals."

At the moment no buildings have been acquired, but use is made of lecture rooms at the Ecole Nationale d'Arts and Métiers of Paris. It is expected that, with the help of all those interested, the students will be allowed to use a part of the buildings now used for other purposes. If so, there will be available a splendid lecture and work room, a library and sample room, a general laboratory, a balance room, a metallography laboratory, a sand laboratory, a research laboratory, some offices, and, in the cellar, some space for heavy machinery.

XUM

# Discussion on Mr. A. J. Richman's Paper on "The Production of Diesel Castings in Pearlitic Cast Iron.*

### Grey Castings with White Runners.

THE CHAIRMAN (Mr. J. Masters) said the Council was to be congratulated on having secured the services of Mr. Richman, and induced him to put before the members the results of his investigation of an important subject, on which there had been a fair amount of discussion during the last few months. He had given them much food for thought.

Mr. Richman had made reference to what were termed freak fractures, the test bars coming out white and the castings quite grey. He had had a similar experience, more especially in castings that were run slowly. In one case, with a casting weighing about three tons, they were trying to get the pearlitic structure, and examination under the microscope showed that they had been very successful. Yet every runner that was broken showed the white iron. In other respects everything was satisfactory.

In connection with the running of the cylinders a point which would appeal to those members who are interested in the manufacture of internal combustion engines was that Mr. Richman ran the cylinders on the flat. In the Manchester district most people cast them on end. If Mr. Richman had cast them in any other way than flat, perhaps he would tell the members what his experience had been.

### Pencil Runners.

The Ronceray method of running had been mentioned. Without doubt in some castings this was essential in order to get good results. He had himself made many experiments with that particular type of runner, and found that was the only way; there was no feeder, and no riser, yet everything came out satisfactorily, there being not a single reject out of 150 made. The casting weighed 1¼ cwts. The runner was ⅜ in. diameter.

### Fracture of Runner as Quality Index.

MR. RICHMAN said the size of the bottom runners on the liners were all a standard size, and, from examination of the fracture of these runners, one could get a good idea of the result of the previous day's cast. If the fracture of the runners were white, gradually merging into a mottled centre, they knew they were right; if it was white right through they were a bit dubious as to the machining qualities of the iron; if they were grey they knew it was slightly soft.

The casting of cylinders on the flat may seem contrary to the usual practice, but when the method of running, the position and size of runners, and casting temperature were all correct, no trouble was experienced. It was found that the slower the running and the hotter the metal, the better the results. The difference in the cost of casting on the flat from casting vertically was very great. Probably the latter method would cost quite 50 per cent. more than the former.

Mr. Masters had mentioned the Ronceray runner. The speaker used this type of runner on a number of castings. He himself, for very small castings used a ¼-in. runner, but he did not put it near the bottom of the casting. In a number of Ronceray castings a small runner was put right at the bottom. Well, if the runner was put near the top so that the runner was practically bonded through the casting, one could use a smaller runner. But with it, in order to get the best results, the job had to be very carefully watched; it must not be left to the men. That was the only drawback in the Ronceray method.

In a number of castings, which would otherwise have to be rod-fed, the results were satisfactory. A ¼-in. round wound runner was used, being placed at the top of the casting. In order to obtain the best results, such jobs have to be very carefully supervised to ascertain that the metal was very hot.

* This Paper has appeared in our last two issues.

### High and Low Phosphorus Iron for Liners.

MR. A. L. KEY asked whether Mr. Richman could give any definite data as to the relative values of high-phosphoric iron and low-phosphoric iron for liners. Mr. Hurst went to a great deal of trouble to acquire information which, according to that authority, proved conclusively that high-phosphoric iron gave the best wearing properties on account of the phosphoric nodules standing out all along the line. He himself (Mr. Key) had worked along those lines, the phosphorous content being above 1 per cent., and they had no trouble with the liners; but whether his liners were better than others in which the phosphorus was at a minimum he could not say, and he would be very glad to know what data Mr. Richman could give as to what was the best wearing material for liners. The majority of people considered that the harder it was, the better it would wear, but one read accounts of cases where relatively soft material had given better duty than the harder material.

Mr. Richman had suggested running cylinder liners slow and extra hot. He himself had made thousands, and found that hot metal was essential—one could not get a good liner without it—but in his opinion he had proved that the quicker they could get it in the better the results.

### Thyssen-Emmel Iron.

Mr. Richman had told them of a bar of Thyssen-Emmel iron which stood a test up to 45 cwts. In his own experience a bar of similar analysis was tested, and the machine would not break it at 49 cwts.; they then used a bit of leverage, and it broke. Had Mr. Richman any record of the deflection of his Thyssen-Emmel bar?

MR. RICHMAN replied that he had not any figures relating to the influence of phosphorus on cylinder liners. He could only generalise from experience. In the liner castings he had shown, one could easily imagine that the port bars on the exhaust side of the liner had to withstand a very high temperature. If the phosphorus was high, the bars would crack.

Mr Key having concurred, MR. RICHMAN continued by stating that, with a number of cylinder heads, pistons, etc., his experience was that the cause of the trouble could be traced to high phosphorus every time. He was not insisting that his methods were unassailable, but his conclusions were based on practice. In saying that he could not imagine anyone who had experience of internal combustion engine castings insisting that the phosphorous content was unimportant. He found that the liners must be run at a certain speed, as the effect of the runner was lost. The object of the runner was to draw the dirt away from under the port cores to the wall separating the two nests of port cores and so up into the sullage heads.

### The Running of Liners.

MR. S. G. SMITH said he had not recently been in contact with practical work to the same extent as some others in the audience, but he had a fairly long experience of castings of this kind, and he had been up against the troubles which Mr. Richman experienced. They had to be solved, and while he did not know that he had always adopted the best method, he had at all events arrived at a solution, which was the chief thing.

They knew that the Lanz iron was made in hot (500 deg. C.) moulds. Mr. Richman had also told them about the Thyssen-Emmel iron. He did not know, and therefore would ask Mr. Richman the question, whether the metal was cupola melted, and a special mixture. Was that also run in hot moulds? The temperature usually adopted by Mr. Richman was an easy temperature. Another

point on which he desired information was whether in any of the castings which had been shown denseners or chills were applied to the heavy parts.

The method of running the liners which had been depicted was used in some of the foundries in the Manchester district. But why did Mr. Richman open out the top runner before the metal reached the ports in one case and in the second allowing the metal to come over the ports before he opened out the top runner? It might be an advantage to do it in that way, and Mr. Richman might have a special reason for it.

### Experience with Thyssen-Emmel Iron.

MR. RICHMAN said it was claimed for the Thyssen-Emmel method that the metal could be cast in a cold mould. The bar he had examined looked as though it was a green-sand casting. It was a 1⅜-in. bar, and gave as much as 26½ tons tensile. Certainly there was a considerable scope for this Thyssen-Emmel iron, but he did not see why one should pay a large sum for it. In the future their own line of experiment was going to be on the lines of altering the tuyere area, the blast pressure, the volume of air, and try to lower the total carbon and raise the silicon content. That would come more into line with the Thyssen-Emmel iron.

### Low-Carbon Cast Iron.

The low total carbon was a feature of their cylinder castings, which were very free from shrinkage trouble. Buchanan always insisted that if one had a No. 4 fracture with this type of iron it gave less trouble from shrinkage than any other iron. He thought Mr. Smalley's researches proved the same thing, that with the pearlitic structure, for that was what it was, it gave a least minimum shrinkage. With their 3.2 total carbon, if they lowered that total carbon slightly they induced shrinkage troubles. Whether that was because they ran so low in silicon he could not say, or whether they could raise the silicon and lower the total carbon and still get good results. He thought it was possible; in his opinion those were the lines on which great success would be achieved.

### Influence of Chills.

He had never been partial to chills. They cured the trouble in one place, but it appeared somewhere else; it was only shifted or spread out over a wider area. With their iron one could not use a chill, as it would produce a white fracture. He remembered a case where hard spots occurred at the same place on liners time after time, and he found out that the box part was just touching the casting, and it struck a ⅜-in. chill, just the shape of the wedge end of the bar in the box. It was a ⅜-in. chill into a liner ¾ in. thick.

Mr. Smith had asked why he opened the top runner when the metal was below the ports, and his methods when the ports were situated all around the liner. The object of the runner was based upon drawing away the dirt from underneath ports, but when the liner had ports all the way round there was no place to drop the metal down, so that the bottom runner was used to fill the mould just above the ports before the top runners were opened.

### The Influence of Hot Moulds.

MR. POOLE (Keighley Laboratories) asked whether the pearlitic structure depended upon the temperature of the mould. Would 100 deg. make all the difference?

MR. RICHMAN insisted that it would make all the difference. Suppose for some reason or other the temperature dropped. When such a casting got into the machining shop the edges of the bosses or any protruding part of the casting were hard, and usually had to be ground off. That was quite all right, but it showed what one got from a warm, yet insufficiently warm, mould, and they could imagine what they would get with a cold mould. He had never cast with a cold mould, so he could not say exactly what happened, but his experience was that if test-bars were cast in a mould at the same temperature as a liner casting and the bars were white right through, so that it was a pretty foregone conclusion what the casting would be like if the mould were cold.

### Making Low-Carbon Cast Iron.

MR. BRIERLEY asked how Mr. Richman proposed to get iron with the desired proportion of total carbon, that is, not exceeding 3.2 per cent. from hematite pig-iron which contained 4.25 per cent. total carbon. Did he use a special cupola for melting the cylinder iron? It was not easy to imagine that he was melting this special iron with common iron in the same cupola; otherwise a good percentage of the special iron would be spoiled by high phosphorus. Were the combined carbon figures in the analyses the percentages in the castings themselves, the liners, or were they the percentages in test-bars?

MR. RICHMAN said the 3.2 per cent. was not very low when one remembered that Mr. Young had 2.8 per cent. He might say they did not use any foreign scrap; it was cylinder scrap. The one drawback was that they did not get enough of it to carry on from day to day. Their first charge they always ran down into a pig. If they were very short they ran down two charges, or three charges; so that they started with a scrap which was very low in total carbon, the steel, and the cupola conditions were regulated to give this. Very often they ran an ordinary iron after the cylinder iron was cast up. If they put on more cylinder iron than they wanted and the phosphorus in that was not too high, they used it as cylinder scrap. If they had a suitable casting, a dry-sand job or similar work, they generally put it in there to get rid of it. That was how they got over the trouble of parting the charges. They had tried putting in an extra deep coke charge, but the total carbon increased straight away. It had been proved conclusively that a thick coke of charge would give high total carbon directly after the incoming charge.

In all cases the combined carbon was taken from liner borings. There was a roughing cut through, then a reamer cut, and these were taken off the reamer cut. It was only fair to take the combined carbon in the borings. If the combined carbon was taken from the test-bar and in the liner the percentage was 0.85 in the liner, and probably nearer 1 per cent. in the test-bar.

Answering a further question, MR. RICHMAN said the mould was about 90 to 100 deg. C., which was not very hot.

### Working Conditions.

MR. KEY put this question, supplementing what Mr. Brierley had said. Supposing Mr. Richman wanted three tons of special iron, how much would he consider he was safe in charging so that he would not get the contents of the softer material following? It was a very difficult matter to separate charges. If the charge of the mixture was put on and then taken away in sections there were wide variations, not in the actual analysis, but in the degree of hardness. In this connection Mr. Key referred to his own experience with a mixture containing about 60 per cent. steel, 10 per cent. hard iron, and 30 per cent. soft iron. One part of the casting had to be so hard that neither a chisel, file nor hammer could make any impression on it, the rest had to be machinable. The weight was 6 cwt. They could not get the metal hard enough for the purpose by charging at the commencement of the blow, for just a little bit of metal from the succeeding charge spoiled it. By charging up this mixture after the day's blow and adding the ordinary coke charge they obtained what they sought, that was 0.7 silicon and 0.15 per cent. phosphorus.

MR. RICHMAN replied that one charge was used more than was required, but they did not drop into very common iron; they changed into iron with 0.8 per cent. phosphorus. They had to be very particular, because there were a number of different thicknesses, and they had to soften off gradually. In cylinder heads the phosphorus must not be high, and they kept a careful watch upon the phosphorus.

### Taking Test-bars.

MR. KEY asked whether the test-bars were taken out each day practically from the same position in the blow? Had Mr. Richman tried taking a succession of test-bars from the furnace and analysing them?

MR. RICHMAN: He never used the first tap.

MR. KEY: Take the first metal you use. Say you take a ladle full for two or three liners, and then you take another ladle away and cast some more. Have you tried taking a succession of test-bars from each tap?

MR. RICHMAN: No.

MR. KEY thought there would be a remarkable inconsistency in the figures from one blow. He would like the author to make that observation.

MR. RICHMAN said for a large-sized liner they sometimes cast the bars first, second or third tap. He did not take the trouble to ascertain what tap it came from; if the mixture was right, that was all that mattered. The results he had given were not from test-bars, but from the liners.

MR. KEY said his experience was that from the first ladle taken away they could get a fairly good consistent analysis, but if they took three ladles out of that one blow the analyses would vary, because if steel was being used and was put on the first charge the steel would come through first, and the first ladle would be much harder than the succeeding ladle.

If three liners were cast from the first ladle they would have the same analysis, but if from another ladle they would be different.

MR. RICHMAN insisted that it was preferable to take away metal in large quantities, the bigger the quantity the more consistent were the results.

In answer to a question by MR. SMITH, the LECTURER pointed out that there are foundrymen who state they can obtain cupola metal carrying 2.8 per cent. carbon.

MR. KEY: We frequently have pig-iron with 2.8 total carbon.

THE CHAIRMAN: 2.8 total carbon has been obtained on several occasions when we were not altogether conversant with pearlitic iron.

MR. SMITH: Put through the cupola?

THE CHAIRMAN: Yes; put through the cupola and cast in moulds.

### Vote of Thanks.

MR. J. S. G. PRIMROSE proposed a vote of thanks to Mr. Richman for his Paper. It could be regarded as a model for future Papers to be read before the Branches; it was an admirable combination of metallurgical theory, with an exposition how to put it into practice.

In seconding the motion MR. H. SHERBURN remarked that apparently the question of pearlitic cast iron was going to take a prominent place in the deliberations of the Institute, and they would look forward with interest to Mr. Richman's contribution to an aspect of importance in foundry practice.

The vote of thanks was carried unanimously.

In replying, MR. RICHMAN remarked that he had to thank Mr. Primrose for the micrographs and lantern slides, and to Mr. R. H. C. Weekes for the analyses cited.

## Catalogues Received.

**Cast-Iron Pipes.**—The monthly stock list for December of cast-iron pipes in stock, issued by the Staveley Coal and Iron Company, Limited, of Chesterfield, is now available. An interesting inset describes the manufacturing conditions employed in these works.

**Mechanical Lorry Duty-Control.**—A leaflet received from Messrs. Andrew Wilson & Company, Limited, of 184, West George Street, Glasgow, sets out the claims for the chronopodography, an instrument which records details of stopping and starting, their duration, and mileage travelled.

**Metal Preservative.**—The D. & S. Laboratories, of Warriston Green Works, Canonmills, Edinburgh, are circularising a leaflet outlining the potentialities and sphere of utility for a material they call Rustprufe, which is a protective coating for iron and steel.

**To Prevent Steel Instruments from Rust.**—Rub them with a little of the following mixture:—½ oz. of camphor dissolved in ½ pint of best olive oil. This is even more effective than common vaseline.

## Notes on High Tensile Brasses.

By M. THIBAUD, Technical Director of the H. Gras Works.

M. Thibaud's Paper was a practical summary of all the information already collected on the subject of high tensile brasses—in France often erroneously termed high tensile bronzes.

He said that at present very few manufacturers were capable of casting such alloys, particularly for naval purposes. This was not because of actual manufacturing secrets, but owing to the very great care which had to be given to the examination of the constituents, the composition of the charges, the making of the moulds, and particularly the arrangement of the runners, risers, and heads, and the temperature and rapidity of the pouring. On these different points the author then gave the following practical details:—

### Influence of the Constituents.

The basis being a 60/40 brass, it contained, in addition to the copper and zinc, variable quantities, of Mn, Fe, Al, Ni. Between 0.2 and 1.0 per cent. of these bodies acted merely as a deoxidising agent, which was specially useful. Above 1.0 per cent. there remained in the brass, in addition, a certain content of these bodies, which improves the mechanical properties of the brass. A content of 2.0 per cent. must not be exceeded, and the best composition, according to the author, was: Al 2.0, Mn 2.0, Fe 1.5, and Ni 2.0 per cent. A tensile strength of 44 tons was obtained, which was maintained when the temperature was increased; the elongation reached about 25 per cent. owing to the nickel.

The author then gave a detailed study of the variations in the mechanical properties in proportion to the variations in content of each of the four elements mentioned, and to variations in the principal constituents, Cu and Zn.

### The Incorporation of Metal Additions.

This was a delicate question, owing to the fact that the melting point of three of them was higher than that of the Cu. Alloys were, therefore, used having a melting point approximating to that of Cu. For Ni, a cupro-nickel of 10 per cent. was used; for Mn, a cupro-Mn of 20 to 25 per cent.; for Fe, a cupro-Fe of 20 to 25 per cent. The incorporation was effected while the bath was covered by a thick layer of wood charcoal to prevent oxidation.

### Melting High Tensile Brass.

This type of brass melted at a higher temperature than copper and passed through the pasty stage. It was, therefore, necessary to pour at a sufficiently high temperature to make it thoroughly liquid, and to prevent oxidation, the bath must be covered with very energetic alkaline-manganese deoxidisers. When a suitable temperature was obtained, the metal was removed from the furnace and skimmed; zinc was added to replace the volatilised Zn, then aluminium. To get rid of the alumina formed, chloride of zinc was added, and the metal was poured quickly.

### Moulding.

As the alloy showed a very high contraction and much dissolved gas, as well as oxides formed at the last moment, special moulds were necessary to permit of the gases escaping and enabling the oxide skin to find its way in the runners and risers. The mould must, therefore, be very permeable, the runners reduced to the minimum at the entrance to the mould, and placed so that the metal, in filling the mould, had a gyratory movement, terminating in the risers and flow-offs. The vertical mould was the best, bottom cast with a very large gate, with a total section greater than that of the ingate to prevent the admission of air. Owing to the great contraction a large feeding head was necessary; in the case of propellers of 8 to 10 tons, for example, the feeding heads had to remain liquid for more than two hours after casting.

The author then gave figures of mechanical properties for a dozen alloys of slightly different composition, and, in conclusion, urged the need for co-operation between founder and moulder, as the mechanical properties desired were of interest only provided that, as a result of good moulding, they were found in the final casting.

# Discussion on Mr. Edgington's Paper on "Machines in a Non-Repetition Foundry."*

THE BRANCH PRESIDENT (MR. G. C. PIERCE), opening the discussion, expressed to Mr. Edgington the appreciation of the members for his Paper. With regard to the 18ft. long bedplate which had been mentioned by the author, he asked how long it had taken to ram that with the sand slinger. He had noticed, he said, that Mr. Edgington still stuck to jolt ramming, though he had a sand slinger in his shop, and he asked, therefore, why the sand slinger had not taken the place of the jolt rammer to a greater extent. He asked the question because the trend of the Paper seemed to be to point out the advantages of the sand slinger over pretty well everything else, and it did seem a little peculiar that the jolt rammer was used to so great an extent.

MR. V. C. FAULKNER (past Branch President) referred to the remark made by the author, in connection with some jobs rammed by the sand slinger, that certain parts, under bars, etc., were tucked by hand. The use of previously prepared oil sand cores for such soft spots suggested itself as being a means of overcoming the difficulty.

MR. M. J. COOPER asked for information with regard to the cost of mounting patterns for jobbing work, and whether the cost of putting many of these jobs on the jolt rammer was warranted. As an example, he mentioned a box 4 ft. square, and upwards. He also asked the thickness of the plates used on the jolt ramming machine for the various sizes of boxes, and what was Mr. Edgington's experience of the use of green sand on jolt ramming machines. Did he find that it was necessary to dry work which was originally done in green sand, and to use any special class of sand for this type of machine? The point of the greatest importance, to his mind, was that of how the cost of production by these machines compared with the cost of production by hand labour. They must take into consideration that the overhead charges in connection with these machines were very high, and, in addition, there were maintenance and power charges. Mr. Edgington had referred to a case in which it had taken four men a fortnight to ram up a number of cores by hand, whereas two men had rammed them up in a week by machine. Would the overhead and maintenance charges in connection with the machines increase the costs to a higher figure in the case of the cores rammed by two men in a week, than in the case of the cores rammed by four men in a fortnight?

MR. A. S. BEECH was rather disappointed that Mr. Edgington had not said more about the transport problem, which was one of the greatest bugbears in the foundry, not only of the sand, but of the boxes, to and from the machines, as well as the boxes from the fettling shop. He asked for information, therefore, in that connection. With regard to the ramming jobs dealt with in jolt ramming machines, he supposed that Mr. Edgington had referred entirely to flat-backed jobs. He would also be interested to know the methods adopted with a big box for flat ramming the job after the jolting was over. Recently, when in Scotland, he had seen pneumatic rammers used, and he wondered whether Mr. Edgington had had any experience in that connection.

MR. EDGINGTON, replying to the Branch President's question as to the speed of ramming in the case of the 18-ft. bedplate, pointed out that, when they reached a certain point, they had to make the joints of the big cores, and, naturally, the machine could not be used on the job the whole of the time. The job was rammed to a certain point, and then left to the moulders, the machine being used for some other job in the interval. On the ramming of the big bedplate mentioned, he had saved something like three days.

Replying to Mr. Faulkner's suggestion as to the practice of tucking under by hand in parts which could not be rammed by the sand slinger, he said this had been his practice for a considerable time even on jolt machines. He made use of oil sand cores very considerably for that purpose, because he could make oil sand cores very much more quickly than he could finish or iron an undercut job, or make a grid to go over it. There were no core irons made for the oil sand cores.

Dealing with Mr. Cooper's question as to the mounting of patterns for some of the big jobs, he said there was no mounting required. They simply brought out a half pattern or a whole pattern, and dropped it on to the plate. The patterns he had discussed had been working for twelve years, and were still good, but in time the screw-holes, used for the screws for holding the jobs down, became larger, and when that happened the next size of tap was used. He had started with 1-in. holes, but in some cases the holes were now 1¼ in., and when they wore out he would go to 1½-in. holes. The thickness of the plates was about 1½ in., and both sides were machined. That was necessary on jolt machines, because, without a flat surface on the table, the job would shift somewhat. The cost of production was much less when using machines as against hand labour. It would be out of place, however, for him to give figures. Machines went wrong very rarely, and they often went six months without being stopped at all for repairs; in fact, he often wondered how he had ever managed without machines, because he had become so used to them. Machine ramming was much better than hand ramming for green sand work, as there was less scabbing. He had not to dry moulds, as he had had to do formerly in many cases, and quite big jobs were made in green sand—much bigger than the 4 ft. square boxes mentioned.

### Transport Problems.

With regard to transport, he agreed with Mr. Beech that this was a bugbear where there were a lot of machines; they could only get one crane up at a time. He had one crane at his foundry which did nothing else but work round one machine. It was a 10-ton crane, geared rather fast, and, as the men did not draw any patterns or put any moulds together under that particular crane, they could work fairly fast. As to the jobs dealt with in the jolt ramming machines, he said he did not stop at anything. The jobs were not by any means all flat-backed ones. If he had a plate with an uneven surface, he rammed up the top part first and put the pattern on the top part, and then rammed the bottom part over the top part in that case.

MR. D. G. MATHER (Messrs. Mather and Smith, Ashford, Kent) said he had been a little disappointed that Mr. Edgington had not said more about small hand machines, because in the South of England there was much more small work done than large. He asked if Mr. Edgington would give his views on the machines which had been illustrated recently in THE FOUNDRY TRADE JOURNAL, namely, the hand jolt machines, as compared with hand squeezers.

MR. EDGINGTON said that, as between hand squeezing machines and small jolt machines for repetition work—and by "repetition work" he meant jobs from which a large number had to be taken—he certainly preferred the small jolt machine, because, with the hand squeezing machine, if the pattern were not very shallow, one did not get the same hardness as with a jolt machine. There were jolt machines with turnover gear which were doing some good work, and he preferred them to the hand squeezers.

MR. R. J. SHAW said the lecturer had referred to "setting the patterns in the moulding boxes by means of wood strips" when preparing to ram them up with the "sand slinger," and he had been wondering what sort of accuracy was obtained and in what type of job that method was used. He presumed it was something that was not very important, as it appeared to him that to match the top and bottom halves of the mould would be rather difficult even if only moderate accuracy was required.

* See issue of December 3.

MR. EDGINGTON illustrated the point by means of a sketch, and said the method was used only for large jobs. The man in charge of the machine cut two very small strips, say 1½ in. wide and perhaps ½ in. deep, and those strips were placed in the box between the sides of the box and the pattern. That method gave him some degree of accuracy in the setting of his pattern, so that he did not get the job an inch over on one side or the other.

MR. J. W. DUNN asked Mr. Edgington if he preferred the sand slinger to the jolt rammer. His own experience was that the jolt rammer was much superior. He had not actually had experience with the sand slinger in the foundries with which he had been concerned regularly, but he had spent a period in a foundry in which these machines were in use, and his impression was that they did not give a uniform job; there were too many joints. The deeper the job, the softer was the ramming at the bottom; when the sand was rammed at the bottom of the box it spread out, and it was harder towards the top of the box. In what way would Mr. Edgington apply the sand slinger to oil sand cores?

MR. EDGINGTON replied that in this country we were not yet educated up to the sand slinger, and we were not getting out of it all that was possible, but we should do in time. His practice was to ram deep bottoms on the jolt machine in preference to the sand slinger. He had not yet made any special tackle for the sand slinger, but in course of time he would make the bottoms with a loose plate, so that there would be an open box to ram into with the sand slinger. When that was rammed up, the plate would be put on and bolted to the box. In many cases, instead of using lifters, he believed it would be advisable to use joint plates. In that case one simply had staples up the box instead of lifters. In a long box one would perhaps get four or five staples standing up when the ramming was finished, instead of 100 or 200 lifters, and in that way he believed we should get over the difficulties with the sand slinger. With regard to ramming up cores with the sand slinger, he had not attempted that yet, and he did not think he would for a time. Oil-sand cores did not require much ramming, and it was sufficient, in some cases, for a man to put the sand into a box and ram with his feet. There were some jobs which would never be made on machines; it must be recognised, of course, that machines had their limitations, but, if a man could use a machine and effect a saving of 25 per cent. thereby, it was up to him to use that machine. There was no doubt that they could be used a great deal more than they had been up to the present, in spite of the difficulties in the foundry.

MR. W. B. LAKE, dealing with the respective merits of the sand slinger and the jolt ramming machine, said he had them working side by side on the same job. That job was a comparatively small one, but his experience was that there was very little to choose between the castings produced by either machine. So long as the head of the sand slinger was kept in the proper condition, he obtained as good a ramming from the sand slinger as from the jolt rammer. He used a steel sand, which was different from green sand.

MR. E. H. BROWN asked whether it was really a paying proposition to use these machines for odd jobs in smaller work, such, for example, as small slide rest sections or similar simple parts, weighing, perhaps, 7, 14 or 28 lbs. apiece. Were the advantages to be derived from the use of machines on that class of work worth the extra expenditure involved?

MR. EDGINGTON said he did not think it would be worth while to use the machines for one job in that class of work, but there was no doubt that when six or a dozen were taken off it was worth while. It must be recognised that every job had to be considered on its merits. It did not follow that, because one had a machine, one must use it for every job, whether it paid to do so or not; every job must be made to stand on its own feet, and it was up to the foundry foreman to use his common sense. It was a question of shop management.

MR. BARTRAM proposed a very hearty vote of thanks to Mr. Edgington for his Paper.

MR. J. ELLIS (Past Branch-President), who seconded, said he had had a good deal to do with moulding machines, and had met with some very curious experiences. He referred to one case in which a man was making a job, at 2d. apiece, on a hand-rammed turn-over moulding machine; in the same foundry the same job could be made on the floor for 1½d. each. In another foundry there was a very elaborate power machine, and motor flywheels were being moulded. At the same time, another foundry not far away was making the same things at a cost which was less than the cost of upkeep of the moulding machine used in the former foundry. He was not antagonistic to the use of moulding machines, because he believed that, rightly applied, they were going to be the salvation of the foundry, but the great difficulty was to get the management of a foundry to appreciate their proper application. Some people installed moulding machines, regardless of the work they were going to put on them, and that was the great fallacy. There were some machines, no doubt, which would give far better results than hand moulding could do, but, on the other hand, there were some which could not, and it was up to the foundryman to have a voice in the selection of these machines. In conclusion, Mr. Ellis expressed the hearty thanks of the meeting to Mr. Edgington.

The vote of thanks was carried with acclamation.

MR. EDGINGTON briefly acknowledged the vote of thanks, and the meeting closed.

## Foundry Organisation.*

By J. LÉONARD, Past-President of the Belgian Foundrymen's Association.

The author commented enthusiastically upon the formation of a committee in Belgium co-operatively to study the problem of industrial production, with the object of correlating the resources and potentialities with its definite needs. He gave the personnel of this committee, and pointed out several questions which he deemed important and wished to see answered in the near future. The first was that of "trend," especially that of trend of business. By the aid of diagrams outlining the position in previous years, M. Léonard showed that the trend of business for the different months of a year, for the same product made at any one works, was always a curve of the same character. Any modifications, if present, could be allowed for in advance, with the result that it should be possible for a works to possess advance knowledge, and month by month be able, if the statistics of previous years had been reliably assembled, to arrange manufacture so as to provide adequate stocks.

The second question was the establishment of the cost of castings. The author was in complete agreement with the thoughts put forward by M. Derulle in the "Fonderie Moderne" of October, 1924. He gave several examples taken from works practice, where startling differences appeared between the price arrived at for similar castings. These differences were directly attributable to errors in arriving at the true cost price. Again, by diagrams he showed how a unified price could be obtained which was infinitely more satisfactory both to the owner and the workman than the guesswork methods so often used. He was of opinion that if the method gave mistakes, they were infinitely less important than those to be associated with the guesswork system.

The third section of the Paper was devoted to records which, he said, did not exist to any real extent, and in any case were not organised. He considered the question from three standpoints: That of the Association Technique de Fonderie; that of the works employing a technical expert, whose duty it was to leave a technical record of his experience, etc.; and that of society in general, since all industrial work was done not for an employer or a company, but for the community.

In the final section of the Paper, which dealt with technical instruction, he referred to the competitions for apprentices held in 1922 and 1923.

* Abstract of a Paper read before the Franco-Belgian Congress at Liege.

# Developing a Pattern Organisation. I.

BY M. E. NICHOLLS.

In many of the engineering works dependent upon outside foundries for casting supplies, the care of patterns, in respect to identification, maintenance, storage and recording, receives but scant attention. It is apparently nobody's job to exercise proper control, and often it is left to the dispatch clerk to locate the pattern and get it away—an unsatisfactory and expensive method, as the following will show:

It is obvious that in most works the dispatch clerk is a busy man, and he cannot afford to spend a lot of time in locating a pattern. This task is accordingly deputed to an underling, and when the pattern is located it receives but cursory attention before being dispatched to the foundry. Even, however, if the dispatch clerk attends to the matter himself, he has not a profound knowledge of patterns, and is unable to state whether the pattern is quite up to date as regards dimensions: whether it is in a real working condition, or (unless there is a comprehensive record) whether there are core boxes or other loose pieces.

### Defective Patterns.

What happens in such circumstances is that trouble is experienced in the foundry, and even this is intensified if it is not discovered until the castings are made and delivered. The foundry would immediately call attention to a missing core-box, but when it is a loose boss that is missing, the omission is probably not detected until the first consignment of castings has been delivered, and this means expense, as well as delay. In like manner a modification that has not been embodied in the pattern cannot be provided against by the foundry, and when the castings are delivered there is an outcry because they are not to the specification. If the condition of the pattern is at all doubtful, it is wise for the foundry to comment upon this: but for fear of offending the customer many foundries refrain, and the result is indifferent castings.

The customer owes a duty to the foundry, just as the foundry owes a duty to the customer. The last-named must provide facilities in the form of accurate and serviceable patterns, and the foundry must see that all reasonable care is taken of these patterns whilst in commission. Some of the patterns provided are merely knocked together —not by any stretch of imagination can they be said to be constructed—and when they get into the foundry they are dismembered and rearranged to suit the ideas of the foundryman. When the job is completed the customer grumbles at the casting, and at the state of his pattern.

Patterns are worthy of better treatment than is accorded them by many engineering firms, for often they are better cared for in the foundry than at home. The storage facilities are crude in the extreme, and in three factories known to the writer the pattern store is a dark loft, the patterns being piled in a heap on the floor. When one specific pattern is required, search is made through the heap, and a wood pattern, at all events, is not improved by being thrown on one side (probably several times) while the search is in progress.

As nowadays many firms are bent upon improving their patterns, the time is opportune to inaugurate an efficient organisation, with a view to maintaining the improvement. It is of no use spending more money on patterns if the old method (or lack of it) is to continue, and it behoves the management to deal thoroughly with the matter. Patterns must be controlled from their inception to the end of their working days—it must be possible to identify them, and to know their whereabouts at any time. They must be inspected and checked before leaving the works for the foundry, and also when they are returned from the foundry.

The buying policy in respect to castings must govern, to no small extent, the procedure in regard to patterns, but it may be taken for granted that the pattern is either in the works or in the foundry. If in the works, then it should be housed in a proper store, and it should have a definite location, which should appear upon the record. If in the foundry the record should state what foundry (assuming there is more than one) and the date that it went there.

The buying policy of one firm may be quite different from that of another, even though the manufacturing policy is somewhat similar. For example, two different firms may be manufacturing upon a repetition basis, turning out substantially the same number of units per month, but whereas one will place orders on the foundry for a six months' supply of castings, the other will order to satisfy the immediate requirement, which means that during the year a large number of orders are placed, each covering a relatively small quantity of castings.

There are probably reasons for the latter policy being favoured, for it may be that the product has not been thoroughly standardised, and that there is always the possibility of changes in design. Again, while one firm is content to place the whole of the orders with one foundry, another firm believes in changing the source of supply occasionally.

With the wisdom or otherwise of either of these policies the present article has no concern, the matter being mentioned only to consider in what way the pattern is affected. In the case where a half-yearly supply of castings is ordered, it is assumed that the pattern will remain in the foundry until the whole of the castings are made, unless the foundry advises the recall of the pattern for making good wear and tear, or the customer recalls it for the purpose of effecting modifications. It is probable also that, immediately upon completion of the half-year's supply of castings, an order for the next half-year's supply will follow, so that the pattern, subject to the contingencies just mentioned, is permanently in the foundry.

This simplifies for the customer the question of pattern inspection, storage and recording, but the matter is entirely different when patterns are constantly arriving from the foundry, and have to be housed for a period in the store before being sent out. In such a case there must be adequate storage accommodation, and the record will show a number of entries, all of which must be quite intelligible. It is in this connection that errors are frequent, the customer writing to the foundry for a pattern that is in his own store, or sending an order for castings in the belief that the pattern is at the foundry, simply because an entry has been omitted from the record. Inspection, too, is a formidable factor, for although many firms omit inspection in respect to patterns received from the foundry, contenting themselves with inspecting the pattern before being sent out again, this is a wrong policy to adopt, for it inevitably leads to delay. The correct procedure is to inspect all patterns immediately upon arrival from the foundry, and all defects made good before the pattern is passed to the store. Then, when instructions are received for the pattern to be sent to a foundry, inspection is of a superficial character, merely to determine that the pattern has not been damaged in any way whilst in the store, and that all core-boxes and loose pieces are available.

The superseding of wood patterns by metal plate patterns is apt to lead to complications, unless due precautions are taken. Many firms are not prepared to scrap thir wood patterns until the plates are firmly established and adequate supplies of castings by this means are assured; and in the same store will be found the old wood-working patterns, together with the wood master patterns off which the metal patterns have been produced. Again, the original record is utilised for recording the progress of the new pattern bearing the same number, which brings about another complication.

These are difficulties which can be overcome only by having a definite policy in respect to the pattern organisation. In regard to the actual patterns, the master patterns and the working patterns can be identified if they are painted in different colours, or if the master patterns are left unpainted, while a new record card should be made out for every new pattern made, the original record being endorsed, "Superseded by metal pattern No. —."

*(To be continued.)*

## Trade Talk.

VICKERS, LIMITED, of Barrow, have received an order from the Admiralty for the machinery for a cruiser to be built at Devonport Dockyard.

THE AVERAGE NET SELLING PRICE of Scottish manufactured iron for September and October has been certified as £11 19s. 1.82d. per ton. This means that there will be an increase in the wages of the workmen of 2½ per cent.

WE are informed that the Nethan Iron Works, Motherwell, projected under the auspices of the late Mr. C. F. MacLaren, have just been purchased by Fredk. Braby & Company, Limited, Glasgow, and are to be reopened.

RICHARDSONS, WESTGARTH & COMPANY, LIMITED, of Hartlepool, Middlesbrough and Sunderland, announce that their London office address (for both marine and land work) is now 121-124, Abbey House, 2, Victoria Street, S.W.1.

THE SCHEME for electricity extensions for the Bristol Corporation has been placed with Vickers, Limited, in conjunction with Metropolitan-Vickers Electrical Company, Limited, subject to the approval of the Electricity Commissioners. The value of the contracts is £1,000,000.

GJERS, MILLS & COMPANY, LIMITED, have re-lighted one blast furnace at their Ayresome Ironworks, Middlesbrough, for the manufacture of hematite iron. Preparations for the re-lighting of the two furnaces at the Linthorpe Ironworks of the Linthorpe-Dinsdale Smelting Company, Limited, have been completed.

THE DUBLIN DOCKYARD COMPANY (VICKERS-IRELAND, LIMITED) have an order from the Wanganui Harbour Board (New Zealand) for the construction of a twin screw fire and salvage tug. The vessel's dimensions are 110 ft. x 24 ft. x 12 ft., and the machinery consists of two sets of triple expansion engines developing 800 i.h.p.

WILLIAM PICKERSGILL & SONS, LIMITED, Southwick, have booked a repeat order from Cairns, Noble & Company, Newcastle. The previous order is still under construction. Each of the vessels is 400 feet in length and of a deadweight capacity of 7,762 tons, and both will be fitted with single-screw turbine engines by Parsons, Wallsend.

BOLCKOW, VAUGHAN & COMPANY, LIMITED, have secured an order for twenty-three thousand tons of steel rails for the Egyptian State Railway, an order obtained in face of keen British, Continental and American competition. The company are also supplying eighty per cent. of the material required for the six new vessels being built on the Wear, and also for the whole of the plates required in the construction of another new vessel.

TWO SUNDERLAND SHIPBUILDING FIRMS have received orders for six large vessels of 9,000 tons deadweight carrying capacity. The six cargo liners have been ordered by the Silver Line, Limited—three from J. L. Thompson & Sons, Limited, and three from Sir James Laing & Sons, Limited. The engines will also be built on the Wear, by Wm. Doxford & Sons, Limited, and will be of the opposed piston type of oil engine. The Sunderland Forge and Engineering Company will supply the auxiliary equipment.

THE Japanese railway authorities are reported to have decided to abandon the American type of rails (F.B. rails on sole plates) and use the British type, namely, bull-headed rails with cast-iron chairs. The British United Press correspondent, cabling from Tokyo regarding this decision, says that it is improbable that any of the contracts for the new rails will be given abroad; what is most likely is that the rails will be made in the Government steel works in Japan.

A MEETING of the Safeguarding Committee, with Colonel Gretton in the chair, on Wednesday received a deputation representing the iron and steel industry, which urged the necessity and importance of the imposition of a duty under the Safeguarding of Industries Act. Mr. C. E. Lloyd, M.P. for Dudley, introduced the deputation, which included Sir Arthur Dorman, Sir Frederick Mills, Mr. Peech, and a representative of the re-rolling section of the trade. It was pointed out that the industry is in a most serious position, that the most keen competition originated in Belgium, and that the imposition of a Safeguarding Duty would enable three million more tons of steel to be produced, which would mean the employment of 120,000 additional men. It was alleged that the cost to the nation of the men unemployed because of foreign imports is not less than £70 a year for each of the 100,000 men out of work; and that the average difference between the cost of imported and British-made material aggregates some four million pounds a year. It was further stated that while the average English wage in the industries is 61s., in Belgium it is 33s. 6d.; Germany 32s. 6d., and France (on the basis of 124 francs to the £) 24s. 2d. The Committee expressed itself as in favour of the contentions of the deputation.

## Obituary.

MR. G. O. SPENCE died on Saturday last. He was formerly a director of the shipbuilding firm of Richardson, Duck & Company, Limited.

MR. W. MURRAY, brassfounder, has died at Fereneze, Barrhead, in his 62nd year. He was for many years with A. Liggat & Company, Caledonian Brass Works, Barrhead, and latterly managing director of Saunders & Conner (Barrhead), Limited.

MR. J. P. HAYWARD, managing director of William Hayward & Sons, Limited, Willenhall Road, Wolverhampton, died at the Red Gables, Compton Road, Wolverhampton, on Saturday last. He was 65 years old, and was the second son of the late Mr. Wm. Hayward, founder of the firm.

MR. JOHN BLENKINSOP has died at his residence, Windsor Crescent, Whitley Bay. The deceased gentleman retired in 1920 after 45 years' service with the Wallsend Slipway and Engineering Company, Limited, during the last 30 of which he was cashier. Mr. Blenkinsop, who was about 68 years of age, was well known in the Willington Quay district.

MR. ROBERT KING died at his residence, Balnacraig, Langbank, on Sunday. The deceased gentleman was associated with David King & Sons, Limited, Keppoch Iron Works, Possilpark, and was the youngest brother of Mr. John King, who is the chairman of the firm. He was educated at St. George's School, and took classes at the Technical College. From his studies he passed into the firm, where he was trained in the business, in whose interests he travelled widely.

MR. I. E. LESTER, a prominent figure in the Midland iron trade, died at his residence, 27, Augustus Road, Edgbaston, after a brief illness. A son of the late Mr. John Lester, of Wednesbury, he was closely associated with the iron trade of the Midlands for many years. Mr. Isaac Lester, for about 20 years, had been connected with the firm of Chas. Akrill & Co., Limited, Golds Green Foundry, West Bromwich, of which firm he was managing director. He had taken an active interest in research work in connection with the iron industry, and was a member of the Iron and Steel Institute, while he was a past-president of the Birmingham Metallurgical Society and the Staffordshire Iron and Steel Institute.

MR. W. H. CARDER, of Tividale, died on November 26, at Ellesmere, Shropshire. About twenty-three years ago the deceased left the employ of Cochrane & Company, Woodside, on his appointment as secretary of the South Staffordshire Mond Gas Company, Dudley Port, a position he retained until his death; and he succeeded the late Sir Gilbert Claughton as a director of the company. He was elected secretary of the Staffordshire Iron and Steel Institute as far back as 1881, succeeding the late Mr. John Lester, who was one of the founders of the association, then and for many years subsequently known as the South Staffordshire Iron and Steel Institute. He retained the secretaryship until about nine years ago, when, in recognition of his long and valuable services, he was presented by the members with a silver tea service and an address. He was elected a life member of the Institute, with which he was associated for a period of 40 years, being one of its oldest members. He was 66 years of age.

## New Companies.

**A. C. Wells & Company, Limited,** 43, Carnarvon Street, Cheetham, Manchester.—Capital £20,000 in £1 shares. Engineers. Directors: H. Adamson and E. Wallwork.

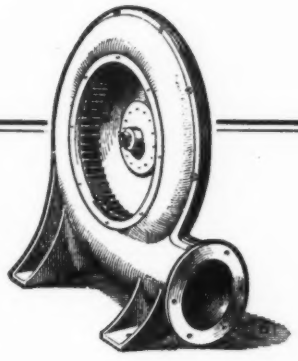
**Black and Decker, Limited.**—Capital £10,000 in £10 shares. Manufacturers and dealers in machinery, etc. Directors: C. Peter, F. A. S. Gwatkin and three others. Solicitors: McKenna & Company, 31-4, Basinghall Street, E.C.

**British Vulpine Engine Company, Limited.**—Capital £10,000 in £1 shares. Directors: C. J. Fox, The Glade, Bush Hill Park, Enfield, and J. W. Smith.

**East London Engineering Works, Limited,** 486, High Road, Leytonstone.—Capital £1,000 in £1 shares. Directors: J. M. Barclay, J. E. Hookway and G. Tufnell.

**F. W. Male & Son, Limited,** Falcon Works, Cartwright Street, Wolverhampton, and at Midland Works, Willenhall, Staffs.—Capital £20,000 in £1 shares (6,000 6¼ per cent. preference and 14,000 ordinary). Engineers and machinists.

**Henry Outram & Sons, Limited,** Canal Works, Cadman Street, Sheffield.—Capital £12,500 in 5,000 10 per cent. cumulative preference and 7,500 ordinary shares of £1. File and steel manufacturers.



TRADE SIROCCO MARK

# High-Pressure Fans

**Single Inlet Cupola Fans**

These Fans are suitable for Cupola work up to 30-in. Water Gauge at moderate speeds of revolution.

**Cast-Iron High-Pressure Fans**

Suitable for Forges or other work calling for static pressures up to 16-in. Water Gauge

**Narrow Pressure Fans**

Give a small volume of air at static pressures up to 30-in. Water Gauge for general high-pressure work

**Double Inlet Cupola Fans**

Suitable for Cupola or other work calling for static pressures up to 30-in. Water Gauge.

DAVIDSON & Co. LIMITED

SIROCCO ENGINEERING WORKS - BELFAST

*Bindo Broadcast No. 444*

JUST LIKE JACK HOBBS

"BINDO"

BEATS ALL RECORDS!!

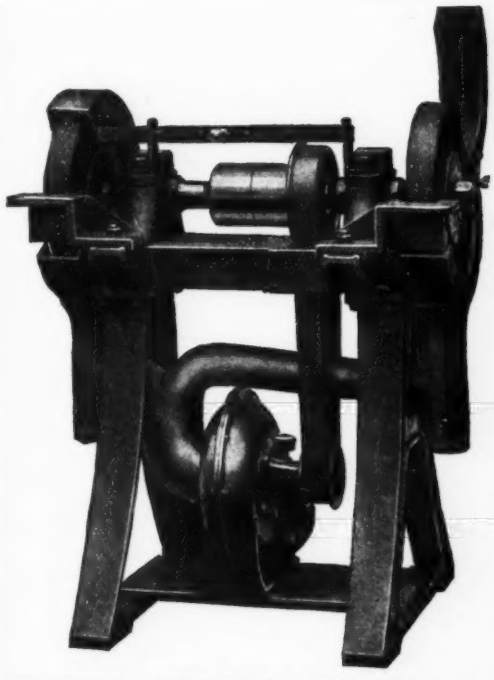
Samples FREE from—

BINDERS INTERNATIONAL Co. Ltd.

56, Mosley Street, Manchester.

Telephone: City 3896

Telegrams: Agglomero, Manchester.



The IDEAL GRINDER for FOUNDRY USE.

(Supplied with or without dust collecting set.)

Stocked by Merchants in all the Large Towns.

*Write for particulars to the Makers—*

T. E. SALTER, LTD.

BLOOMFIELD TIPTON, STAFFS.

# IRON AND STEEL MARKETS.

## Pig-Iron.

**MIDDLESBROUGH.**—In accordance with general expectations, the recent activity in the Cleveland iron market has been promptly followed by a fractional advance in prices, the Tees-side ironmasters having last week decided upon the restoration of the system of agreed minimum prices, and these were fixed at 6d. per ton above the rate previously quoted in the case of home sales, with the further addition of another 6d. per ton where the iron is for export. The general advance of 6d. per ton in home prices is justified on the ground that costs of production have advanced to a much greater extent than the rise in pig-iron prices. The following is the new list of agreed quotations:—Home: No. 1 foundry, 69s.; No. 3 Cleveland G.M.B., 66s. 6d.; No. 4 foundry, 65s. 6d.; No. 4 forge, 65s. per ton, all f.o.t. Export: No. 1 foundry, 69s. 6d.; No. 3 G.M.B., 67s.; No. 4 foundry, 65s.; No. 4 forge, 65s. 6d. per ton f.o.b.

In the hematite market consumers are pressing for deliveries, and some firms have no iron to sell until January next. Naturally, in such conditions, the price is very firm, and in some cases has been advanced, mixed numbers being quoted at 75s. 6d. and No. 1 76s. per ton. On the North-West Coast conditions are similar, with prices also firm but unchanged, as follow:—Bessemer mixed numbers are quoted at £4 1s. 6d. c.i.f. Welsh ports, £4 5s. per ton delivered at Glasgow, £4 8s. 6d. per ton delivered at Sheffield, and £4 12s. 6d. per ton delivered at Birmingham.

**LANCASHIRE.**—Demand in this locality for foundry pig-iron is quiet and rather dull. Sellers do not admit that they need to make any concessions in the current prices, but it is clear that the tone of the market is not so strong as it was a fortnight ago. Sellers of Derbyshire iron in Manchester usually quote 73s. 6d. per ton, but at the furnaces 65s. 6d. and even 65s. has been spoken of, and this would equal only 72s. 6d. delivered. For Lincolnshire No. 3 72s. delivered here is quoted, and it is possible that 71s. 6d. would be accepted. The demand here for Scotch iron is quiet, and the price seems rather weak at 95s. to 95s. 6d. per ton delivered.

**THE MIDLANDS.**—Movements in the markets for foundry pig in this area continue practically without features of interest, the near approach of Christmastide having the usual quietening effect upon buying. It would appear that the chief call for foundry iron of late has emanated from the small foundries and from the light casting manufacturers. Current quotations are as follow:—Derbyshire No. 3 foundry, 65s.; Staffordshire No. 3 foundry, 65s.; Northants. No. 3 foundry, 62s. 6d.

**SCOTLAND.**—There is still no improvement to report in the condition of the Scotch pig-iron market. There seems to be a lack of confidence as to the future, and consumers are not inclined to make purchases ahead. The price now quoted for No. 3 Scotch is a shade easier at 77s. 6d. per ton at the furnaces.

## Finished Iron.

There is no sign of any appreciable expansion of demand such as will bring any of the idle works into operation; in fact, some of those at work are losing about 25 per cent. of their turns through inability to obtain a sufficiency of orders. And this applies to some producers of best-quality irons, which are certainly in better demand than the commoner grades. Others, however, are able to keep in full operation, and these are people who have some sort of speciality, such as particularly large sections for wagon building. Producers of crown and commoner quality irons do not find it any easier to keep going. They are still losing quite a lot of export trade to firms more favourably situated for doing this class of trade; and of course cheaper steel also continues to displace a lot of iron. However, things do not seem to be any worse than they have been for quite a long time. If anything, demand has improved slightly, but it needs to expand a lot more to bring general activity. Quotations may be described as firm in the main, but it is admitted that "cuts" have to be made to meet competition.

## Steel.

English semis are again rather weak, and are reported to be had in ample quantities at £6 2s. 6d. and less. This is in comparison with £5 5s., or probably less, for Continental "semis." Not much business is passing in either at present, although substantial deliveries are being made under old contracts. Sectional steel and plates continue to be cut about in the scramble for output. It is reported that North country producers would take less than the price quoted, probably as low as £7, if the inquiry were particularly acceptable. Much the same thing applies to plates, and small bars also are subject to keen competition. Galvanised sheets are not altered, but are very firm at recent prices. In the tinplate market buyers do not seem disposed to buy ahead to any extent. There has been a fair inquiry of late, transactions being confined mainly to spot lots and for near shipment, but it is doubtful if there are now any sellers below 20s.

## Scrap.

The improved demand for pig-iron recently has, so far, had little beneficial effect upon the markets for scrap metal, for which, at present, demand is anything but brisk. In Lancashire, however, there has been rather a better call for cast scrap from the foundries lately, but in this case there is no rise in price yet, probably because there is too much on the market. The finer lots of textile cast scrap are not at all plentiful, and some dealers are holding out for 77s. 6d. per ton for this material, although only 75s. has been paid so far. For ordinary broken machinery scrap 72s. 6d. per ton is usually quoted, and 70s. for common cast scrap.

## Metals.

**Copper.**—Quite unexpectedly, and certainly not justified by the statistical position, values of standard copper have again been easier, the principal influences on the market at the moment being the falling off in the legitimate consumptive demand, both in this country and the Continent, and the weakness reported in America. The political crisis in France and the uncertainty as to what may yet happen in that country until financial equilibrium is somewhat restored has also had its effect in the accentuation of the depression. Current quotations:—*Cash*: Thursday, £59 5s.; Friday, £59 15s.; Monday, £59 5s.; Tuesday, £59 7s. 6d.; Wednesday, £59 5s.

*Three Months*: Thursday, £60 5s.; Friday, £60 15s.; Monday, £60 7s. 6d.; Tuesday, £60 7s. 6d.; Wednesday, £60 5s.

**Tin.**—Since the issue of the statistical returns for November movements in the market for tin have experienced a rather erratic tendency, the monthly figures showing considerably increased supplies, being responsible for some heavy selling. Whether the loss will be regained very quickly is doubtful, but it is obvious that at the moment the market lacks any particular impetus to carry prices up very far, and the recent anticipations of a runaway market are receding. Current quotations:—*Cash*: Thursday, £284 5s.; Friday, £287 10s.; Monday, £286 17s. 6d.; Tuesday, £286 17s. 6d.; Wednesday, £287 7s. 6d.

*Three Months*: Thursday, £279 5s.; Friday, £281 15s.; Monday, £280 10s.; Tuesday, £280 5s.; Wednesday, £280 12s. 6d.

**Spelter.**—It is reported that stocks of zinc have increased during the past month by some 300 tons, and values have accordingly declined, the movement being accentuated by a falling off in the demand from galvanisers. The large increase in the Belgian output is also influencing the situation, with the result that values are now down to a lower level than has been experienced for some time. Current quotations:—*Ordinary*: Thursday, £38 8s. 9d.; Friday, £38 13s. 9d.; Monday, £38 15s.; Tuesday, £38 10s.; Wednesday, £38 5s.

**Lead.**—The market for soft foreign pig has of late been adversely affected by the weaker tone in America, and prices have declined under free selling. The continued heavy arrivals from Australia coming on an overbought market have brought the quotation down still further. Home consumers have been reserved in their purchases, and there has been an absence of demand from the Continent. Current quotations:—*Soft foreign (prompt)*: Thursday, £35 7s. 6d.; Friday, £35 15s.; Monday, £35; Tuesday, £34 15s.; Wednesday, £34 5s.

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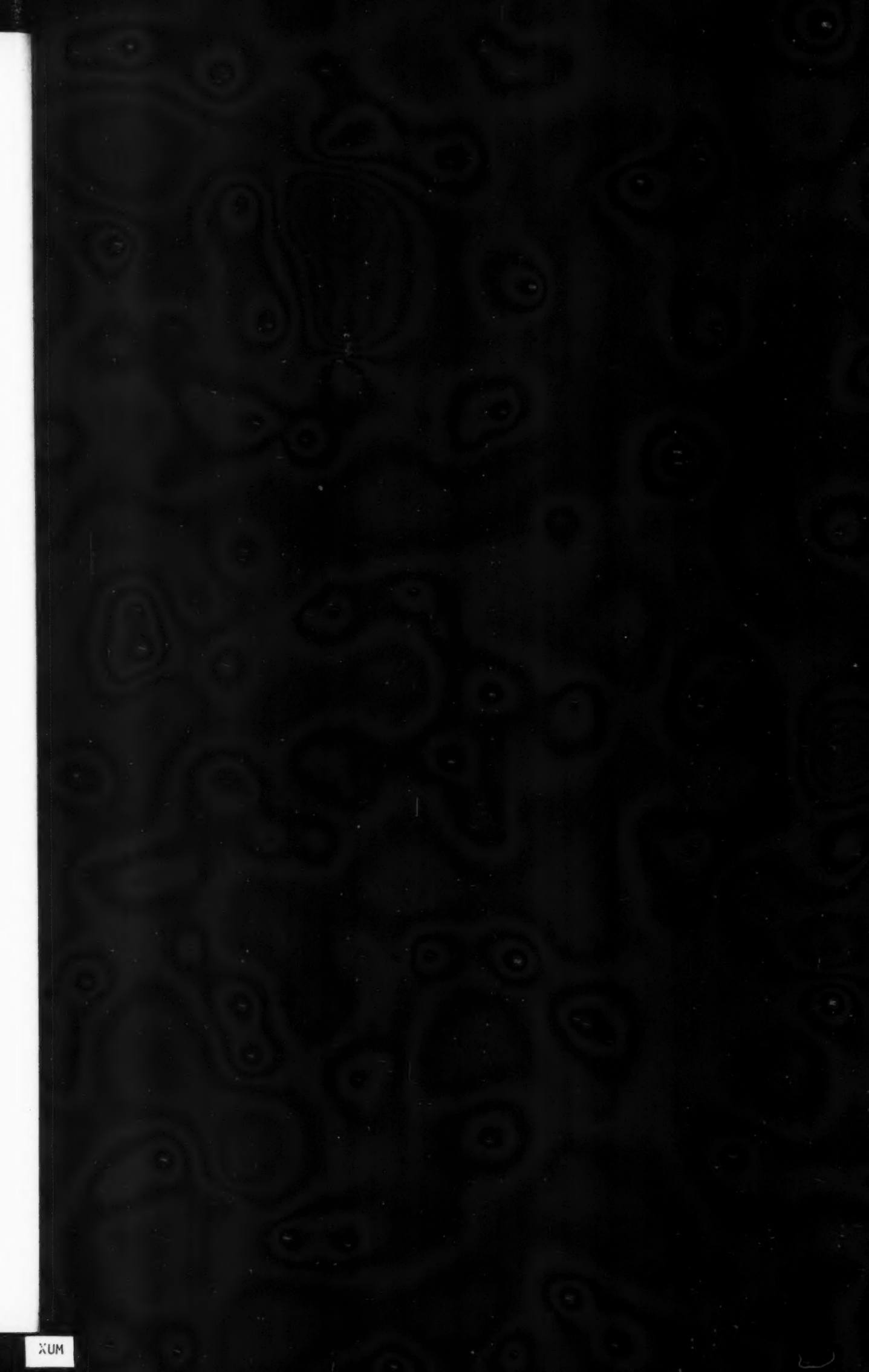
DURING a special education week in Barrow-in-Furness, a lecture was given to the members of the Barrow and District Association of Engineers, apprentices of the district, and students of the technical school, by Mr. W. F. Clement (of the Barrow Hematite Steel Company), the subject being the "Making of a Steel Rail: From Raw Material to Finished Product." In connection with this lecture Commander C. W. Craven (of Vickers, Limited) has offered a substantial prize for the best essay written by a Vickers' apprentice on this particular subject.


XUM

# GOLDENDALE

## THE PREMIER

# CYLINDER PIG IRON

SELECTED, FRACTURED & SUPPLIED TO ANALYSIS.

## DENSE GREY FRACTURE

UNRIVALLED FOR CLEANLINESS & FLUIDITY.

EXCELLENT MACHINING QUALITIES.

SUITABLE FOR
STEAM, HYDRAULIC, GAS & OIL ENGINES.
HIGH CLASS ELECTRICAL CASTINGS.

SPECIAL QUALITY FOR AUTOMOBILE & AERO ENGINES.

MAKERS:—
GOLDENDALE IRON COMPANY LTD., STOKE ON TRENT.
*Contractors to THE ADMIRALTY, WAR OFFICE, HOME & COLONIAL GOVERNMENTS & RAILWAYS.*

SOLE AGENTS:—
**WESTOBY & RAWSTRON**
326 & 327, ROYAL EXCHANGE, MANCHESTER.

ENQUIRIES SOLICITED.

TELEGRAMS: "RAWSTRON." TELEPHONE: CITY 1405.

# WEEKLY PRICE CURRENT.

## COPPER.

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 59 | 5 | 0 |
| Three months | 60 | 5 | 0 |
| Electrolytic | 65 | 5 | 0 |
| Tough | 62 | 0 | 0 |
| Best selected | 63 | 0 | 0 |
| Sheets | 90 | 0 | 0 |
| India | 77 | 0 | 0 |
| Wire bars | 66 | 0 | 0 |
| Do. Dec.–Jan. | 65 | 15 | 0 |
| Do. Jan. | 65 | 15 | 0 |
| Ingot bars | 65 | 15 | 0 |
| H.C. wire rods | 70 | 0 | 0 |
| Off. av. cash, Nov. 61 | 6 | 10½ | |
| Do., 3 mths. Nov. 62 | 6 | 3 | |
| Do., Sttlmnt, Nov. 61 | 6 | 5½ | |
| Do., Electro, Nov. 68 | 2 | 10⅝ | |
| Do., B.S., Nov. | 65 | 10 | 0 |
| Aver. spot price copper, Nov. | 61 | 6 | 5 |
| Do., wire bars, Nov. 68 | 7 | 10½ | |
| Solid drawn tubes | | 13½d. | |
| Brazed tubes | | 13½d. | |
| Wire | | 10d. | |

## BRASS.

| | |
|---|---|
| Solid drawn tubes | 12d. |
| Brazed tubes | 13½d. |
| Rods, drawn | 11½d. |
| Rods, extd. or rlld. | 7½d. |
| Sheets to 10 w.g | 10½d. |
| Wire | 10½d. |
| Rolled metal | 9¾d. |
| Yellow metal rods | 7½d. |
| Do. 4 × 4 Squares | 8d. |
| Do. 4 × 3 Sheets | 8½d. |

## TIN.

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 287 | 7 | 6 |
| Three months | 280 | 12 | 6 |
| English | 286 | 10 | 0 |
| Bars | 288 | 0 | 0 |
| Straits | 290 | 10 | 0 |
| Australian | 288 | 10 | 0 |
| Eastern | 287 | 15 | 0 |
| Banca | 296 | 0 | 0 |
| Off. aver. cash, Nov. | 284 | 14 | 1⅞ |
| Do., 3 mths., Nov. | 281 | 14 | 9⅝ |
| Do., Sttlmt. Nov. | 284 | 13 | 6⅝ |
| Aver. spot., Nov. | 284 | 13 | 7 |

## SPELTER.

| | £ | s. | d. |
|---|---|---|---|
| Ordinary | 38 | 5 | 0 |
| Remelted | 37 | 0 | 0 |
| Hard | 32 | 0 | 0 |
| Electro 99.9 | 42 | 10 | 0 |
| English | 39 | 2 | 6 |
| India | 33 | 0 | 0 |
| Zinc dust | 46 | 0 | 0 |
| Zinc ashes | 15 | 0 | 0 |
| Off. aver., Nov. | 38 | 13 | 5½ |
| Aver., spot, Nov. | 39 | 0 | 9½ |

## LEAD.

| | £ | s. | d. |
|---|---|---|---|
| Soft foreign ppt. | 34 | 5 | 0 |
| English | 35 | 15 | 0 |
| Off. average, Nov. | 36 | 10 | 10 |
| Average spot, Nov. | 36 | 17 | 5½ |

## ZINC SHEETS, &c.

| | £ | s. | d. |
|---|---|---|---|
| Zinc sheets, English | 46 | 10 | 0 |
| Do. V.M. ex whf. | 45 | 0 | 0 |
| Rods | 53 | 0 | 0 |
| Boiler plates | 44 | 10 | 0 |
| Battery plates | 45 | 0 | 0 |

## ANTIMONY.

| | £ | s. | d. |
|---|---|---|---|
| Special brands, Eng. | 89 | 10 | 0 |
| Chinese | 81 | 0 | 0 |
| Crude | 63 | 0 | 0 |

## QUICKSILVER.

| | £ | s. | d. |
|---|---|---|---|
| Quicksilver | 15 | 0 | 0 |

## FERRO-ALLOYS AND STEEL-MAKING METALS.

| | |
|---|---|
| Ferro silicon 25% | £9 10 0 |
| 45/50% | £11 15 0 |
| 75% | £21 12 6 |
| Ferro-vanadium—35/40% | 15/3 lb. va. |
| Ferro-molybdenum—70/75% c. free | 6/3 lb. |
| Ferro-titanium—23/25% carbonless | 1/1 lb. |
| Ferro-phosphorus, 20/25%, | £19 17 6 |
| Ferro-tungsten—80/85%, c.fr. | 1/8 lb. to 1/8½ |
| Tungsten metal powder—98/99% | 1/10½ to 1/11½ lb. |
| Ferro-chrome—2/4% car. | £34 15 0 |
| 4/6% car. | £23 15 0 |
| 6/8% car. | £23 2 6 |
| 8/10% car. | £22 10 0 |
| Ferro-chrome—Max. 2% car. | £41 0 0 |
| Max. 1% car. | £49 10 0 |
| Max. 0.70% car. | £56 10 0 |
| 70%, carbonless | 1/5½ lb. |
| Nickel—99%, cubes or pellets | £172 to £177 |
| Cobalt metal—98/99% | 10/– lb. |
| Aluminium 98/99% | £120 |
| Metallic Chromium—96/98% | 3/6 lb. |
| Ferro-manganese (net)—76/80%, loose | £15 7 6 |
| 76/80%, packed | £16 7 6 |
| 76/80%, export | £15 5 0 |
| Metallic manganese—94/96%, carbonless | 2/– lb. |

Per ton unless otherwise stated.

## HIGH-SPEED TOOL STEEL.

| | |
|---|---|
| Finished bars, 14% tungsten | s. d. 2 6 |
| Finished bars, 18% tungsten | 3 0 |

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. and over .. 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Do. under ¼in. to $\frac{7}{16}$ in. .. .. 1/– lb.
Flats, ½in. × ¼in. to under 1 in. × ⅜ in. 3d. lb.
Do. under ½in. × ¼in. 1/– lb
Bevels of approved sizes and sections 6d. lb.
Bars cut to length 10% extra
Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turningds and warf 1d.

Per lb. net, d/s steel makers' work

## SCRAP.

| | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| South Wales— Hvy. steel | | 3 | 10 | 0 | | |
| Bundled steel & shrngs. | 3 | 2 | 6 | to 3 | 6 | 0 |
| Mixed iron & steel | 3 | 1 | 6 | to 3 | 3 | 0 |
| Heavy cast iron | 3 | 4 | 0 | to 3 | 5 | 0 |
| Good machinery for foundries | 3 | 7 | 6 | to 3 | 10 | 0 |
| Cleveland— Heavy steel | | 3 | 1 | 0 | | |
| Steel turnings | | 2 | 2 | 6 | | |
| Cast iron borings | | 2 | 0 | 0 | | |
| Heavy forge | | 4 | 2 | 6 | | |
| Bushelled scrap | | 3 | 5 | 0 | | |
| Cast-iron scrap | 3 | 0 | 0 | to 3 | 1 | 0 |
| Lancashire— Cast-iron scrap | 3 | 10 | 0 | to 3 | 12 | 6 |
| Heavy wrought | | 3 | 7 | 6 | | |
| Steel turnings | | 2 | 0 | 0 | | |
| London — Merchants' buying prices delivered yard. | | | | | | |
| Copper (clean) | | 51 | 0 | 0 | | |
| Brass (clean) | | 39 | 0 | 0 | | |
| Lead (less usual draft) | | 31 | 0 | 0 | | |
| Tea lead | | 27 | 0 | 0 | | |
| Zinc | | 25 | 0 | 0 | | |
| New aluminium cuttings | | 92 | 0 | 0 | | |
| Braziery copper | | 46 | 0 | 0 | | |
| Gunmetal | | 46 | 0 | 0 | | |
| Hollow pewter | | 195 | 0 | 0 | | |
| Shaped black pewter | | 142 | 0 | 0 | | |

## PIG-IRON.

*(f.o.t. unless otherwise stated).*

| | |
|---|---|
| N.E. Coast— Foundry No. 1 | 69/– |
| Foundry No. 3 | 66/6 |
| Foundry No. 4 | 65/6 |
| Forge No. 4 | 65/– |
| Hematite No. 1 | 76/– |
| Hematite M/Nos. | 75/6 |
| N.W. Coast— Hem. M/Nos. d/d Glas. | 85/– |
| ,, d/d Birm. | 92/6 |
| Midlands— Staffs common* | — |
| ,, No 4 forge | 59/6 |
| ,, No. 3 foundry | 65/– |
| Shrops. basic | 70/– |
| ,, Cold blast, ord.* | 185/– |
| ,, ,, roll iron* | 190/– |
| * d/d Birmingham. | |
| Northants forge | 56/– |
| ,, fdry No. 3 | 62/6 |
| Derbyshire forge | 59/6 |
| ,, fdry. No. 3 | 65/– |
| ,, basic | 65/– |
| Scotland— Foundry No. 1 | 82/6 |
| ,, No. 3 | 77/6 |
| Hem. M/Nos. | 77/6 |
| Sheffield (d/d district)— Derby forge | 63/6 |
| ,, fdry. No. 3 | 69/– |
| Lincs. forge | 68/– |
| ,, fdry. No. 3 | 70/– |
| E.C. hematite | 86/– |
| W.C. hematite | 88/6 |
| Lincs. (at furnaces)— Forge No. 4 | 62/– |
| Foundry No. 3 | 64/– |
| Basic | 64/– |
| Lancashire (d/d eq. Man.)— Derby forge | 67/– |
| ,, fdry. No. 3 | 73/6 |
| Northants foundry No. 3 | 75/3 |
| Dalzell, No. 3 | 110/– |
| Summerlee, No. 3 | 95/– |
| Glengarnock, No. 3 | 95/– |
| Gartsherrie, No. 3 | 95/– |
| Monkland No. 3 | 95/– |
| Coltness, No. 3 | 95/– |
| Shotts, No. 3 | 95/– |

## FINISHED IRON & STEEL.

*Usual District deliveries for iron; delivered consumers' station for steel.*

| Iron— | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| Bars (cr.) | 11 | 5 | 0 | to 12 | 10 | 0 |
| Angles | | | | 11 | 10 | 0 |
| Tees to 3 united ins. | | | | 12 | 0 | 0 |
| Nut and bolt | | | | 11 | 0 | 0 |
| Hoops | 14 | 0 | 0 | to 15 | 0 | 0 |
| Marked bars (Staffs.) f.o.t. | | | | 14 | 0 | 0 |
| Gas strip | 12 | 10 | 0 | to 12 | 15 | 0 |
| Bolts and nuts ¾ in. × 4 in. | | | | 16 | 15 | 0 |
| Steel— Ship plates | 7 | 5 | 0 | to 8 | 7 | 6 |
| Boiler plts. | | | | 11 | 10 | 0 |
| Chequer plts. | £9 | 5 | 0 | to 9 | 15 | 0 |
| Angles | £7 | 0 | 0 | to 7 | 5 | 0 |
| Tees | £8 | 0 | 0 | to 8 | 5 | 0 |
| Channels | £6 | 12 | 6 | to 7 | 2 | 6 |
| Joists | £7 | 0 | 0 | to 7 | 5 | 0 |
| Rounds and Squares 3 in. to 5½ ins. | | | | 8 | 10 | 0 |
| Rounds under 3 in. to ¾ in. | | | | 8 | 5 | 0 |
| Flats, over 5 in. wide and up | | | | 9 | 0 | 0 |
| Flats, 5in. to 1½in. | | | | 8 | 0 | 0 |
| Rails, heavy | | | | 8 | 0 | 0 |
| Fishplates | | | | 12 | 0 | 0 |
| Hoops (Staffs.) | | | | 10 | 10 | 0 |
| Black sheets, 24g. | | | | 11 | 5 | 0 |
| Galv. cor. sheets, 24g. | | | | 16 | 15 | 0 |
| Galv. fencing wire 8g. plain | | | | 14 | 0 | 0 |
| Billets, soft | £6 | 0 | 0 | to 7 | 10 | 0 |
| Billets, hard | | | | 8 | 2 | 6 |
| Sheet bars | | | | 6 | 5 | 0 |
| Tin bars d/d | | | | 6 | 5 | 0 |

## PHOSPHOR BRONZE.

| | Per lb. | basis. |
|---|---|---|
| Strip | 1 | 3 |
| Sheet to w.g. | 1 | 3¼ |
| Wire | 1 | 3½ |
| Rods | 1 | 3 |
| Tubes | 1 | 8½ |
| Castings | 1 | 2 |

Delivery 3 cwt. free
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

## NICKEL SILVER, &c.

| | Per lb. |
|---|---|
| Ingots for raising | 9d. to 1/3 |
| Rolled— To 9 in. wide | 1/3 to 1/9 |
| To 12 in. wide | 1/3½ to 1/9½ |
| To 15 in. wide | 1/3½ to 1/9½ |
| To 18 in. wide | 1/4 to 1/10 |
| To 21 in. wide | 1/4½ to 1/10½ |
| To 25 in. wide | 1/5 to 1/11 |
| Ingots for spoons and forks | 9d. to 1/5½ |
| Ingots rolled to spoon size | 1/– to 1/8½ |
| Wire round— 3/0 to 10 G. | 1/6½ to 2/1½ |

with extras according to gauge.

## AMERICAN IRON & STEEL.

| At Pittsburgh unless otherwise stated. | Dols. |
|---|---|
| No. 2X foundry, Phila. | 23.76 |
| No. 2 foundry, Valley | 22.26 |
| No. 2 foundry, Birm. | 21.00 |
| Basic | 21.76 |
| Bessemer | 22.76 |
| Malleable | 22.26 |
| Grey forge | 21.76 |
| Ferro-mang. 80% d/d | 115.00 |
| Bess. rails, h'y, at mill | 43.00 |
| O.-h. rails, h'y at mill | 43.00 |
| Bess billets | 35.00 |
| O.-h. billets | 35.00 |
| O.-h. sheet bars | 36.00 |
| Wire rods | 45.00 |
| | Cents. |
| Iron bars, Phila. | 2.22 |
| Steel bars | 2.00 |
| Tank plates | 1.90 |
| Beams, etc. | 1.90 |
| Skelp, grooved steel | 1.90 |
| Skelp, sheared steel | 1.90 |
| Steel hoops | 2.50 |
| Sheets, black, No. 28 | 3.25 |
| Sheets, galv., No. 28 | 4.50 |
| Sheets, blue an'l'd, 9 & 10 | 2.40 |
| Wire nails | 2.65 |
| Plain wire | 2.50 |
| Barbed wire, galv. | 3.35 |
| Tinplate, 100 lb. box | $5.50 |

## COKE (at ovens).

| | |
|---|---|
| Welsh foundry | 32/6 to 37/6 |
| ,, furnace | 20/– to 25/– |
| Durham & North. foundry | 30/– to 33/– |
| ,, furnace | 17/– |
| Other Districts, foundry | 30/– to 33/– |
| ,, ,, furnace (basis) | 11/9 |

## TINPLATES.

f.o.b. Bristol Channel ports.

| | | |
|---|---|---|
| I.C. Cokes, | 20×14, box | 20/1½ |
| ,, | 28×20, ,, | 40/3 |
| ,, | 20×10, ,, | 29/4½ |
| ,, | 18¾×14, ,, | 21/– |
| C.W. | 20×14, ,, | 18/4½ |
| ,, | 28×20, ,, | 36/6 |
| ,, | 20×10, | 25/4½ |
| ,, | 18¾×14, ,, | 18/7½ |

Terneplates 28 × 20, 36/3 per box basis f.o.b.

## SWEDISH IRON.

| | |
|---|---|
| Bars, hammered | £19/0 to £20/0 |
| Rolled Ord. | £16/0/0 to £16/10/0 |
| Nail rods | £16 5 0 to £16 15 0 |
| Keg. steel nom. | £33 to £35 |
| Faggot steel nom. | £22 to £25 |
| Blooms, according to quality | £10 to £14 |
| Pig-iron | £6 15 0 to £7 0 0 |

all f.o.b. Gothenburg.

**TUBES.**

Up to and incl. 6 in.

Gas .. 55% } Tube prices
Water .. 50% } are
Steam .. 45% } now free.

**DAILY FLUCTUATIONS.**

**Standard Copper** (Cash).

| | £ | s. | d. | |
|---|---|---|---|---|
| Dec. 3 | 59 | 5 | 0 | dec. 10/- |
| ,, 4 | 59 | 15 | 0 | inc. 10/- |
| ,, 7 | 59 | 5 | 0 | dec. 10/- |
| ,, 8 | 59 | 7 | 6 | inc. 2/6 |
| ,, 9 | 59 | 5 | 0 | dec. 2/6 |

**Electrolytic Copper.**

| | £ | s. | d. | |
|---|---|---|---|---|
| Dec. 3 | 65 | 10 | 0 | dec. 15/- |
| ,, 4 | 66 | 0 | 0 | inc. 10/- |
| ,, 7 | 65 | 15 | 0 | dec. 5/- |
| ,, 8 | 65 | 10 | 0 | ,, 5/- |
| ,, 9 | 65 | 5 | 0 | ,, 5/- |

**Standard Tin** (Cash).

| | £ | s. | d. | |
|---|---|---|---|---|
| Dec. 3 | 284 | 5 | 0 | dec. 40/- |
| ,, 4 | 287 | 10 | 0 | inc. 65/- |
| ,, 7 | 286 | 17 | 6 | dec. 12/6 |
| ,, 8 | 286 | 17 | 6 | No change |
| ,, 9 | 287 | 7 | 6 | inc. 10/- |

**Tin** (English ingots).

| | £ | s. | d. | |
|---|---|---|---|---|
| Dec. 3 | 283 | 10 | 0 | dec. 40/- |
| ,, 4 | 286 | 10 | 0 | inc. 60/- |
| ,, 7 | 286 | 0 | 0 | dec. 10/- |
| ,, 8 | 286 | 0 | 0 | No change |
| ,, 9 | 286 | 10 | 0 | inc. 10/- |

**Zinc Sheets** (English).

| | £ | s. | d. | |
|---|---|---|---|---|
| Dec. 3 | 46 | 10 | 0 | No change |
| ,, 4 | 46 | 10 | 0 | ,, ,, |
| ,, 7 | 46 | 10 | 0 | ,, ,, |
| ,, 8 | 46 | 10 | 0 | ,, ,, |
| ,, 9 | 46 | 10 | 0 | ,, ,, |

**Spelter** (ordinary).

| | £ | s. | d. | |
|---|---|---|---|---|
| Dec. 3 | 38 | 8 | 9 | inc. 2/6 |
| ,, 4 | 38 | 13 | 9 | ,, 5/- |
| ,, 7 | 38 | 15 | 0 | ,, 1/3 |
| ,, 8 | 38 | 10 | 0 | dec. 5/- |
| ,, 9 | 38 | 5 | 0 | ,, 5/- |

**Lead** (English).

| | £ | s. | d. | |
|---|---|---|---|---|
| Dec. 3 | 36 | 5 | 0 | dec. 10/- |
| ,, 4 | 36 | 10 | 0 | inc. 5/- |
| ,, 7 | 36 | 5 | 0 | dec. 5/- |
| ,, 8 | 36 | 0 | 0 | ,, 5/- |
| ,, 9 | 35 | 15 | 0 | ,, 5/- |

## AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.

| Year. | Jan. | Feb. | March. | April. | May. | June. | July. | August. | Sept. | Oct. | Nov. | Dec. | Yearly Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. |
| 1887 .. .. | 37 5 | 35 10 | 34 4 | 34 4 | 34 1 | 34 10 | 34 4 | 34 5 | 33 9 | 31 10 | 31 8 | 33 6 | 34 2 |
| 1888 .. .. | 32 2 | 31 1 | 31 5 | 31 9 | 30 11 | 31 5 | 32 4 | 33 5 | 34 8 | 34 2 | 33 11 | 33 10 | 32 7 |
| 1889 .. .. | 33 8 | 35 0 | 37 5 | 38 9 | 38 6 | 37 10 | 40 1 | 43 4 | 44 1 | 51 5 | 64 7 | 61 1 | 43 10 |
| 1890 .. .. | 60 3 | 53 1 | 51 0 | 47 4 | 42 2 | 41 5 | 43 2 | 45 7 | 47 9 | 47 10 | 47 4 | 43 1 | 47 6 |
| 1891 .. .. | 42 1 | 41 10 | 39 9 | 38 7 | 40 9 | 41 0 | 40 8 | 39 8 | 40 4 | 39 11 | 38 8 | 38 1 | 40 1 |
| 1892 .. .. | 37 7 | 35 7 | 36 10 | 37 10 | 39 2 | 40 11 | 39 11 | 39 10 | 40 0 | 38 6 | 37 6 | 37 4 | 38 5 |
| 1893 .. .. | 36 0 | 34 3 | 34 4 | 34 2 | 33 10 | 34 8 | 35 3 | 35 5 | 35 4 | 34 8 | 34 7 | 35 9 | 34 10 |
| 1894 .. .. | 35 8 | 35 11 | 36 1 | 36 1 | 35 5 | 35 5 | 35 5 | 35 11 | 36 6 | 35 8 | 35 8 | 35 1 | 35 9 |
| 1895 .. .. | 34 7 | 34 4 | 34 4 | 34 8 | 35 6 | 35 2 | 36 1 | 37 1 | 38 10 | 38 6 | 37 11 | 37 6 | 36 3 |
| 1896 .. .. | 37 3 | 38 4 | 38 7 | 38 1 | 37 4 | 37 4 | 36 11 | 36 11 | 37 11 | 39 2 | 40 5 | 40 5 | 38 3 |
| 1897 .. .. | 41 2 | 40 4 | 40 5 | 39 2 | 39 7 | 40 9 | 39 6 | 40 5 | 41 7 | 42 5 | 41 5 | 40 4 | 40 7 |
| 1898 .. .. | 40 9 | 40 8 | 40 6 | 40 0 | 40 7 | 39 11 | 40 4 | 41 11 | 43 0 | 44 11 | 49 1 | 44 3 | 42 0 |
| 1899 .. .. | 46 10 | 47 11 | 47 9 | 49 10 | 55 11 | 62 10 | 71 6 | 65 9 | 67 7 | 68 8 | 70 0 | 66 9 | 60 5 |
| 1900 .. .. | 67 10 | 68 10 | 73 10 | 76 2 | 74 2 | 68 6 | 69 3 | 71 4 | 70 9 | 67 8 | 63 6 | 53 6 | 68 9 |
| 1901 .. .. | 48 0 | 46 6 | 45 8 | 45 5 | 45 10 | 44 7 | 44 6 | 45 3 | 45 3 | 45 3 | 43 6 | 43 1 | 45 3 |
| 1902 .. .. | 43 11 | 46 7 | 46 9 | 47 11 | 48 10 | 49 7 | 50 9 | 52 1 | 53 6 | 52 9 | 50 9 | 47 11 | 49 3 |
| 1903 .. .. | 47 3 | 48 9 | 51 10 | 49 0 | 46 1 | 46 2 | 46 7 | 46 8 | 45 7 | 43 6 | 42 10 | 41 11 | 46 4 |
| 1904 .. .. | 42 3 | 42 7 | 43 3 | 44 7 | 44 0 | 42 10 | 42 9 | 43 3 | 43 1 | 43 9 | 46 1 | 48 7 | 43 11 |
| 1905 .. .. | 48 11 | 48 0 | 49 6 | 50 1 | 51 5 | 45 6 | 45 9 | 47 5 | 48 8 | 52 11 | 52 9 | 53 3 | 49 6 |
| 1906 .. .. | 53 9 | 50 1 | 48 1 | 48 8 | 50 2 | 50 3 | 50 6 | 53 0 | 54 6 | 56 8 | 58 6 | 62 4 | 53 0 |
| 1907 .. .. | 60 4 | 56 6 | 54 10 | 56 0 | 61 1 | 58 1 | 57 8 | 57 8 | 55 7 | 54 8 | 50 8 | 50 0 | 56 2 |
| 1908 .. .. | 48 5 | 49 3 | 51 7 | 51 10 | 51 6 | 51 2 | 50 0 | 51 4 | 52 0 | 49 8 | 49 4 | 48 11 | 50 8 |
| 1909 .. .. | 48 10 | 48 1 | 46 9 | 47 9 | 48 4 | 48 9 | 48 6 | 50 5 | 51 3 | 51 11 | 51 2 | 50 7 | 49 4 |
| 1910 .. .. | 51 10 | 51 3½ | 51 7¼ | 50 10 | 49 10 | 49 2 | 48 10 | 49 8¼ | 49 3½ | 49 7¾ | 49 6¾ | 49 10 | 50 [illegible]4 |
| 1911 .. .. | 49 11½ | 49 2½ | 48 5 | 46 11 | 46 4 | 46 6 | 46 11½ | 47 4 | 47 0 | 46 7 | 47 4 | 48 1 | 47 7 |
| 1912 .. .. | 50 0 | 49 5½ | 51 1¼ | 53 7½ | 54 4 | 55 1 | 57 5½ | 64 6¾ | 61 7½ | 66 8½ | 67 8 | 58 0 | 58 5½ |
| 1913 .. .. | 66 11½ | 63 8½ | 64 8 | 67 1¾ | 66 3 | 56 9 | 56 3½ | 55 8 | 55 4 | 53 0 | 50 1 | 50 4 | 58 10 |
| 1914 .. .. | 50 11 | 51 5½ | 51 0¾ | 51 4½ | 51 6 | 51 6¾ | 51 5 | 52 3 | 51 5 | 50 1 | 50 3 | 53 0 | 51 4½ |
| 1915 .. .. | 55 7 | 56 6 | 61 0 | 66 7 | 65 2 | 66 10¾ | 65 4 | 66 0¾ | 65 3 | 65 11 | 69 10½ | 75 7½ | 65 7¼ |
| 1916 .. .. | 80 2 | 91 6 | 87 4½ | 86 10 | 82 6 | 82 6 | 87 6 | 87 6 | 87 6 | 87 6 | 87 6 | 87 6 | 85 10 |
| 1917 .. .. | 87 6 | 87 6 | 87 6 | 92 6 | 92 6 | 92 6 | 92 6 | 92 6 | 92 6 | 92 6 | 92 6 | 95 0 | 91 3 |
| 1918 .. .. | 95 0 | 95 0 | 95 0 | 95 0 | 95 0 | 95 0 | 95 0 | 95 0 | 95 0 | 95 0 | 95 0 | 95 0 | 95 0 |
| 1919 .. .. | 95 0 | 95 0 | 95 0 | 95 0 | 152 6 | 160 0 | 160 0 | 160 0 | 160 0 | 160 0 | 160 0 | 160 0 | 137 8 |
| 1920 .. .. | 175 0 | 175 0 | 187 6 | 200 0 | 208 0 | 217 6 | 217 6 | 221 0 | 225 0 | 225 0 | 225 0 | 225 0 | 209 3 |
| 1921 .. .. | 222 6 | 195 0 | 150 0 | 126 0 | 120 0 | 120 0 | 120 0 | 136 3 | 127 0 | 120 0 | 110 0 | 100 0 | 137 4 |
| 1922 .. .. | 92 6 | 90 0 | 90 0 | 90 0 | 90 0 | 90 0 | 89 0 | 87 3 | 92 6 | 92 6 | 92 6 | 91 3½ | 90 7[illegible] |
| 1923 .. .. | 94 6 | 108 9 | 125 6 | 129 4½ | 128 5 | 136 0 | 128 1½ | 121 11 | 97 1½ | 97 0 | 100 0 | 110 6½ | |
| 1924 .. .. | 99 10 | 97 3½ | 91 9 | 93 9 | 91 9 | 89 10½ | 87 9 | 85 0 | 82 5½ | 80 2½ | 81 9 | 81 9 | 88 7½ |
| 1925 .. .. | 80 4½ | 78 10½ | 78 0 | 77 3½ | 76 0 | 73 10¼ | 71 7½ | 69 10½ | 67 10½ | 66 6 | 66 1½ | — | — |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